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NEW TRICHOPTERA AND A REDESCRIPTION OF *LEPTOCELLODES FLAVEOLA* ULMER.

By the late MARTIN E. MOSELY.

IN this paper I am giving descriptions of two new species of Trichoptera which I have held over for many years for inclusion in some appropriate paper.

One species which I have placed in a new genus, *Atopsychodes*, agrees very closely with species in the genus *Atopsyche*, but is characterised by lateral filaments not present in the latter genus.

The redescription of *Leptocellodes flaveola* Ulmer arises from the incorrect

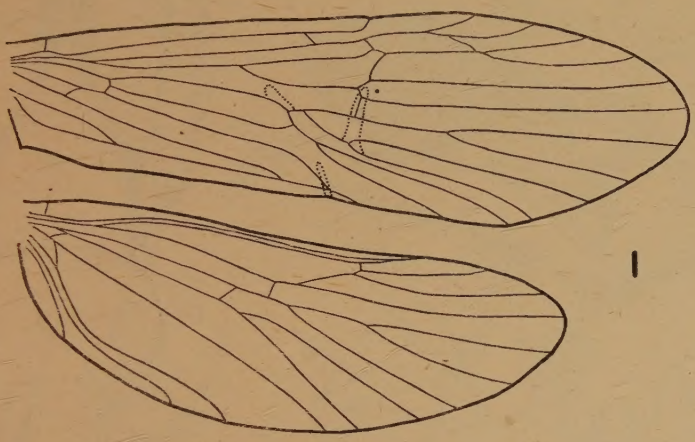


FIG. 1.—*Atopsychodes cira* sp. n., ♂, wings.

determination of the species by Navás as *Notanatolica poujadi*. The figures given have been drawn from Navás's type in the Paris Museum, so that the synonymy may be established beyond all doubt.

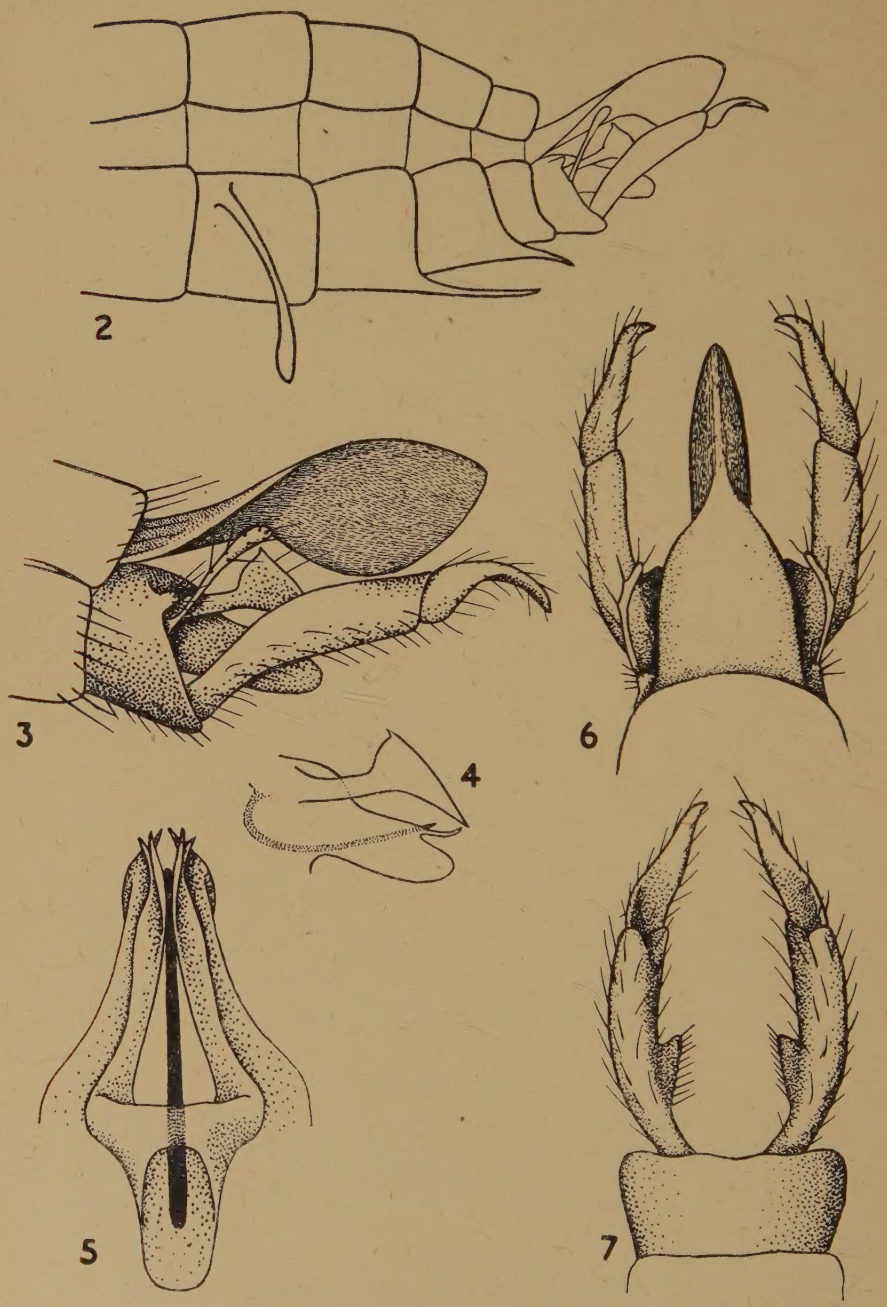
Atopsychodes gen. n.

The genus *Atopsychodes* differs from *Atopsyche* in two particulars: firstly, the presence of a pair of rather stout, almost spatulate lateral filaments on the 5th abdominal segment; secondly, a slight difference in the neuration of the posterior wing; in *Atopsyche*, a cross vein joins the radius to the sector before its furcation, whilst in *Atopsychodes* the radius is connected after furcation.

Genotype: *Atopsychodes cira* sp. n.

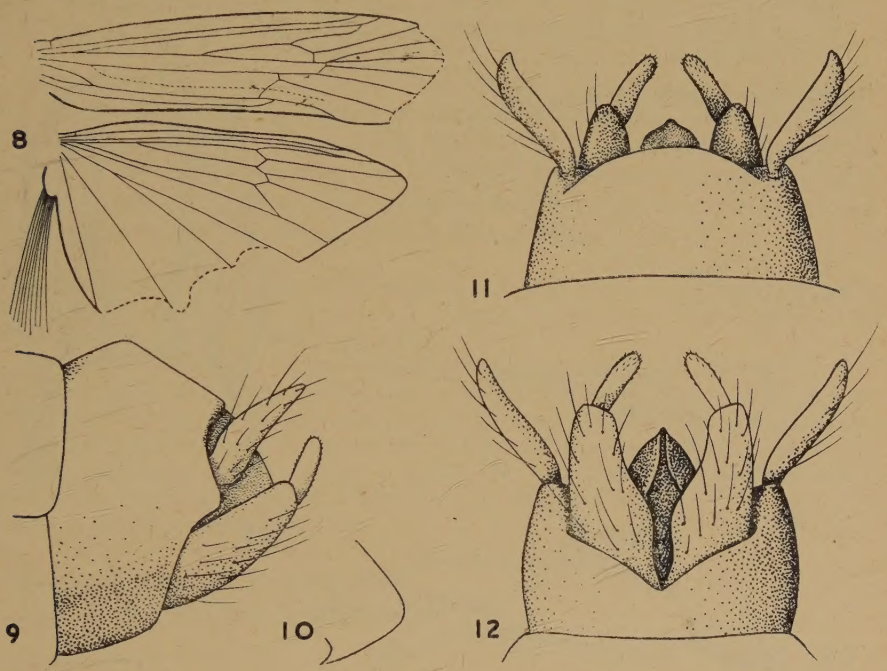
Atopsychodes cira sp. n. (figs. 1–7).

Head, dark fuscous with dark fuscous hairs; antennae ochraceous, darker towards the apex with faint annulations at the joints; palpi dark ochraceous; legs ochraceous; wings



FIGS. 2–7.—*Atopsychodes cira* sp. n., ♂. (2) Abdomen from the side; (3) genitalia, lateral; (4) upper penis-cover, penis and sheaths, lateral; (5) ventral; (6) genitalia, dorsal; (7) ventral.

ochraceous with whitish patches on the membrane, as shown in the figure, and long semi-recumbent hairs along the nervures. Genitalia, ♂, ninth dorsal segment produced in a long plate, broad at the base from above, with a narrow stem from the side ; and narrowing to an acute apex, which is very broad from the side ; the margins of this plate are turned outwards in the basal half to make blade-like lateral ridges ; arising from beneath a pair of rounded and fringed warts are the slender intermediate appendages, slightly less than half the length of the dorsal plate with dilated apices carrying a few stiff hairs ; upper penis-cover in the form of a pair of hammer-headed plates with slender stems, the " hammer-head " with a strongly produced and acute distal angle and a less produced upper angle ; penis-sheaths appear as two deep plates, each with a small slender process arising on the upper surface directed backwards along the sheath, and separated from it by a



FIGS. 8–12.—*Marilia crea* sp. n., ♂. (8) Wings ; (9) genitalia, lateral ; (10) upper penis-cover, lateral ; (11) genitalia, dorsal ; (12) ventral.

narrow excision ; penis is a slender rod between them ; inferior appendages two-jointed, basal joint large and concave with a projecting plate on the inner surface towards the base ; apical joint twisted and slightly less than half the length of the basal joint, terminating in an acute apex ; ventral processes to the 6th and 7th segments and a pair of short, thick, and slightly curved filaments, expanding towards the apices, situated on the 5th segment towards its lateral margins.

Length of anterior wing, ♂, 11 mm., ♀, 13 mm.

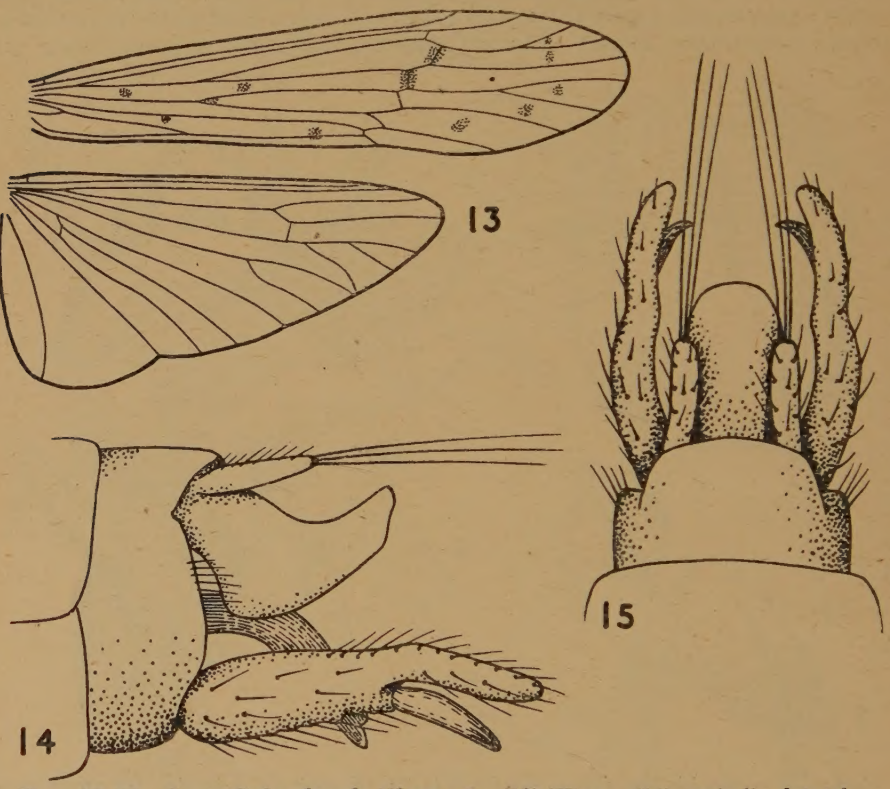
COSTA RICA : Irazu, 2200–2500 mm. 21–28.v.1930, Reimosa ; Irazu, 6–7000 ft. H. Rogers.

Type ♂ (Irazu, H. Rogers) in the collection of the British Museum ; paratypes ♂ and ♀ in the collections of the Vienna Museum.

Atopsyche iana Mosely nom. nov.
for *Atopsyche spinosa* Mosely.

Atopsyche spinosa Mosely, 1931, *Trans. ent. Soc. Lond.* **79** : 545.

Dr. Ulmer (*in lit.*) informs me that Navás' genus *Ventrarma* is synonymous with *Atopsyche* and this entails the renaming of the British Guiana species *spinosa*, as this name is preoccupied in *Ventrarma*. A careful re-examination of the type suggests that in the anterior wing the radius is forked, and in the



FIGS. 13–15.—*Leptocellodes flaveola* Ulmer, ♂. (13) Wing; (14) genitalia, lateral; (15) dorsal.

posterior wing there is a cross-vein uniting the radius to the sector before the furcation of the latter vein.

I may add that the neuration of the wings, both anterior and posterior, towards the apex, is extremely obscure.

Marilia crea sp. n. (figs. 8–12).

Eyes black, very large in the ♂, meeting each other at the vertex of the head; palpi fuscous; antennae dark ochraceous, basal joint large, clothed with short, whitish hairs, remaining joints annulated with white; wings brownish yellow, posterior with a tuft of long dark hairs arising from a membranous process at the basal anal angle; legs ochraceous, tarsi and femora of the anterior pair much darker; spurs doubtful.

Genitalia ♂, terminal dorsal segment rounded ; superior appendages rather long, somewhat spindle-shaped, apices acute ; upper penis-cover large, yellowish, directed downward, apex from the side, terminating in a small finger ; inferior appendages two-jointed, basal joint stout, second joint rather short and cylindrical ; margin of the ninth ventral segment widely excised.

Length of anterior wing, ♂, 9 mm.

COSTA RICA : San José.
Type ♂ in the collection of the British Museum.

Leptocellodes flaveola Ulmer (figs. 13–15).

Ulmer, 1911, *Ann. Soc. ent. Belg.* **55** : 22.
Notanatolica poujadi Navás, 1927, *Bol. Soc. Iber. Ci. Nat.* **26** (9) : 73.
Mosely, 1936, *Trans. R. ent. Soc. Lond.* **85** ; 107.

During the course of a revision of the TRIPLECTIDINAE in 1927, it transpired that the species described as *Notanatolica poujadi* by Navás was in fact *Leptocellodes flaveola* Ulmer. Through the courtesy of the authorities of the Paris Museum, I was able to examine the insect and figures were made at the time, but not hitherto published. For convenience, these figures and a description of the species in English are included in this paper.

Head ochraceous, eyes black, palpi yellowish, antennae pale-cream coloured with dark annulations ; *legs* yellowish ; spurs, 0, 2, 2 ; wings vitreous, anterior with twelve dark-yellowish brown spots as shown in the figure.

Male genitalia.—Terminal dorsal segment slightly produced and rounded ; welded to it is a large upper penis-cover, apical margin rounded from above, apex directed slightly upward from the side and the upper margin, from this aspect, shallowly and widely excised ; superior appendages cylindrical, slightly shorter than the upper penis-cover ; penis fleshy, directed somewhat downward ; inferior appendage two-branched, second branch terminating in a claw-shaped apex, slightly shorter than the main branch.

Length of anterior wing, ♂, 10·7 mm.

ECUADOR, Loja, A. Poujade, 1909.
Type ♂ in the Paris Museum.

A PRELIMINARY ACCOUNT OF THE FORMS OF *ANOPHELES LEUCOSPHYRUS* DÖNITZ (DIPTERA : CULICIDAE).

By J. A. Reid, M.Sc.

(*Entomologist, Institute for Medical Research, Kuala Lumpur, Malaya.*)

1. Introduction.

Although *Anopheles* (*Myzomyia*) *leucosphyrus* has long been known or suspected as a vector of malaria in certain areas, especially in Borneo and Sumatra (Roper, 1914 ; Doorenbos, 1931 ; Stoker, 1934, etc.), it is only comparatively recently that its potential importance as a vector has become more widely recognized. This has been due mainly to the work of Clark and Choudhury in Assam (1941), of McArthur in British North Borneo (1947), and the experiences of the Armies in Burma, e.g. Covell (1944 : 411), Afridi and Arthur (1945). In all these instances trapping and dissection showed that *leucosphyrus* was a very efficient vector of malaria. Consequently it has become a matter of importance to clear up the systematics of this species.

Anopheles leucosphyrus, which is readily distinguished by the broad white band covering the tibio-tarsal joint of the hind leg, has a wide distribution in the Oriental region, ranging from south-west India eastward to the Philippines and Celebes. It appears to consist of at least six or seven distinct forms, four of which occur in the Malay Peninsula. The purpose of the present paper is to draw attention to this situation, and to provide notes on nomenclature and a tentative key for separating the adult females of these forms, pending the completion of a fuller account at a later date. Also to give some evidence which, though scanty at present, does seem to point to one among these forms as being that which has been found infected in the recent investigations quoted.

For descriptions of *leucosphyrus* and *leucosphyrus* var. *hackeri*, see Christophers (1933) and Gater (1934 and 1935).

Acknowledgments.

This account is based partly on the specimens in the collection of this Institute (I.M.R.)[1] and partly on examination of the specimens in the collections at the British Museum (Natural History) (Mr. H. Oldroyd) (B.M.), the Institute for Tropical Hygiene, Amsterdam (Professors N. H. Swellengrebel and S. L. Brug) (B.), and the London School of Hygiene and Tropical Medicine (Professor P. A. Buxton and Mr. H. S. Leeson) (L.S.H.T.M.). A few specimens were also seen in the Pasteur Institute, Paris (Professor E. Roubaud and Dr. J. Colas-Belcour) (P.), and in the collection of Dr. de Meijere at the Zoological Museum, Amsterdam (Dr. Kruseman) (A.). I wish to thank all these gentlemen, and the Keeper of Entomology at the British Museum, Mr. N. D. Riley, for their very kind help. My thanks are especially due to Professor Buxton, who has

[1] The letters in brackets following the name of each collection are the abbreviations used to indicate the location of the specimens seen, when giving their collection data.

gone out of his way to help me in my work on this and other species of *Anopheles*. I was greatly assisted by the grant of study leave and travelling expenses from the Malayan Government.

2. Key to the Adult Females.

Definitions.

Many of the characters employed in the key which follows are those used by King and Baisas (1936) in their important paper on the Philippine forms of

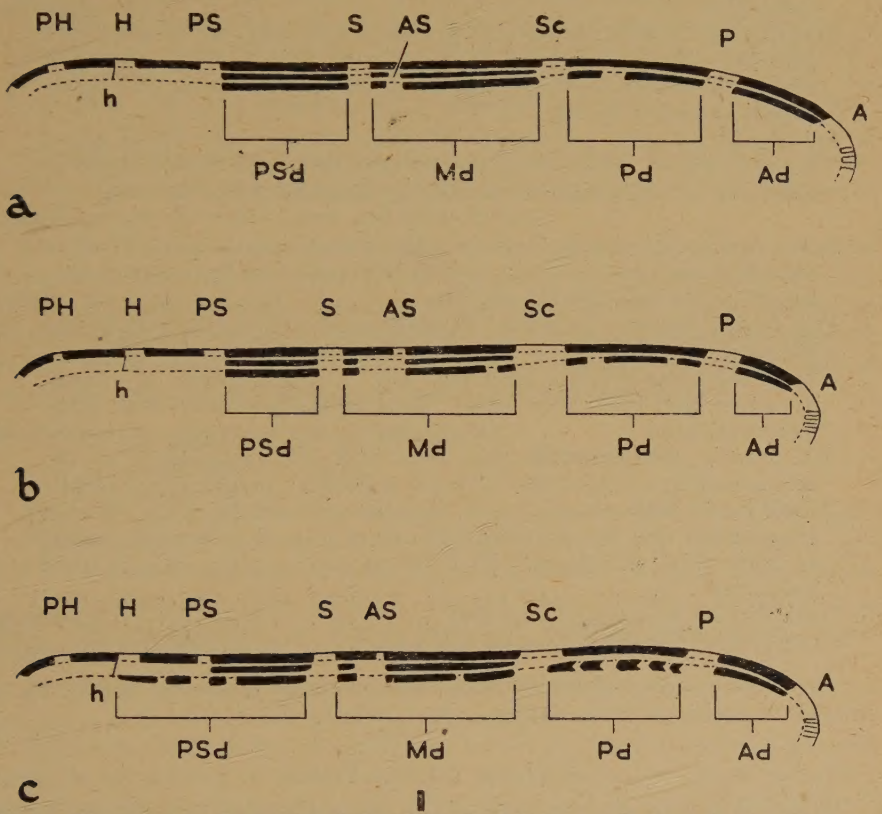


Fig. 1.—Diagrams to show typical distributions of light and dark marks on the costa, subcosta and vein 1 in: (*a*) *hackeri*, *elegans* and *riparis*; (*b*) *pujutensis*; (*c*) *leucosphyrus* s.s. Explanation of symbols: *h*, humeral cross vein, pale areas; A, apical; AS, accessory sector; H, humeral; P, preapical; PH, prehumeral; PS, presector; S, sector; Sc, subcostal; dark marks; Ad, apical; Pd, preapical; Md, middle; PSd, presector. Nomenclature after Christophers, 1933, p. 18.

the *leucosphyrus* group; in particular the number of pale interruptions (hereafter called "divisions") in the presector and preapical dark marks on vein 1 (fig. 1), the presence or absence of a dark stripe on the ventral aspect of the apical pale band of the hind tibia (called the "hind tibial pale band"), and the presence or absence of a basal pale band on hind tarsus four. This last character appears to be only of minor or perhaps local value.

Provisional key to the adult females of the *Anopheles leucosphyrus* group.

1. Palps clearly shorter than the proboscis which is longer than the fore femur 3
   Palps and proboscis subequal, the latter not longer than the fore femur . 4
2. Preapical and middle dark marks on vein 1 nearly always with more than one division each (fig. 1*b*). Fourth hind tarsus without basal pale band, costa often with accessory sector pale spot. Apical and preapical pale bands of palps broad, apical segment half or more than half white . . . . . var. *pujutensis*.
   Preapical and middle dark marks on vein 1 with only one division each (fig. 1*a*). Fourth hind tarsus often with basal pale band, costa without accessory sector pale spot. Apical and preapical pale bands of palps broad or narrow 3
3. Apical and preapical pale bands of palps narrow, only tip of apical segment white. Palps much shorter than proboscis, shorter by more than length of last segment, usually by about length of last two . . . . . var. *hackeri*.
   Apical and preapical pale bands of palps broad, apical segment half or more than half white. Palps shorter than proboscis by not more than length of last segment, usually less . . . . . var. *elegans*.
4. Vein 1 with presector dark mark divided, usually extending basally into the presector pale area ; preapical and middle dark marks usually with more than one division each (fig. 1*c*). No dark stripe on ventral aspect of hind tibial pale band. Hind tarsus four often with small basal pale band . . . . *leucosphyrus* type form and var. *balabacensis*.
   Vein 1 with presector dark mark undivided, the same length as the corresponding marks on the costa and subcosta ; preapical and middle dark marks with not more than one division each (fig. 1*a*). With a more or less well marked dark stripe on at least the proximal portion of hind tibial pale band. Hind tarsus four usually without basal pale band . . . . . 5.
5. Costa without prehumeral pale spot . . . . . *A. cristatus*.
   Costa generally with prehumeral pale spot . . *A. leucosphyrus* var. *riparis*.

In general, males can be identified without much difficulty, chiefly by the number of divisions in the dark marks on vein 1.

3. Notes on the Forms.

Whilst it is probable that most of the forms discussed here will before long be regarded as good species, there are some, such as *elegans* and the form from Celebes (p. 45), the status of which is uncertain at present; see discussion on page 45. For this reason varietal rank has been preferred for the time being, whilst the non-committal term " form " is employed in discussion.

Anopheles leucosphyrus var. *pujutensis* Colless, 1948.[2]

Adult.—The adult females resemble those of *hackeri*, in having a proboscis considerably longer than the palps, and longer than the fore femur. They differ principally as shown in the following couplet :

[2] Colless, D. H., 1948, *Proc. Linn. Soc. N.S.W.* **73** : 101. A timely meeting with Mr. Colless and examination of his specimens, some of which he has kindly presented to this Institute, has saved me from creating a synonym.

Apical and preapical pale bands of palps broad, especially the apical, so that apical segment of palps is half or more than half white. Preapical dark mark on vein 1 usually (17/20) with more than one division ; middle dark mark on vein 1 usually (18/20) with more than one division ; costa in about half the specimens (10/20) with an accessory sector pale spot (fig. 1*b*). Fourth hind tarsus without basal pale band. Ventral aspect of hind tibial pale band without, or with only a small dark stripe *pujutensis*.

Apical and preapical pale bands of palps narrow, especially the apical, so that only the extreme tip of apical segment is white. Preapical dark mark on vein 1 with only one division ; middle dark mark on vein 1 with only one division, the accessory sector pale spot (20/20) ; no accessory sector pale spot on costa (20/20) (fig. 1*a*). Fourth hind tarsus in about half the specimens (12/20) with a small basal pale band. Ventral aspect of hind tibial pale band generally with a proximal dark stripe . . *hackeri*.

The tip of the palps broadly or minutely pale is the most reliable distinguishing character. The long proboscis and the wing characters will distinguish the males from the other forms and from *hackeri*.

Larva.—The larvae cannot at present be distinguished from those of *leucosphyrus* type form and var. *riparis*, but like these two, they are distinguished (at least in Malayan specimens) from the larvae of *hackeri* by the absence of the well-developed pigmented palmate hairs on the second abdominal segment, present in the latter. In addition, the inner submedian prothoracic hair of *pujutensis* is smaller and more slender and has fewer branches :

pujutensis	10–16, average 12	20 measured.
hackeri	17–28, „ 22	

Types : C.S.I.R., Canberra, Australia ; paratypes in Brit. Mus. (Nat. Hist.)

Specimens seen : Borneo : North, Membakut, 1913, 3 ♀ (*R. Roper*) (1 ♀ in B.M., specimen noted by Edwards ; 2 ♀ L.S.H.T.M.) ; East, Balik Papan, 3 ♀ (B.). Sumatra : Deli, 4 ♀ (B.) ; Moeara Tebo, 1 ♀ (B.). Malay Peninsula : Various localities in Negeri Sembilan, Selangor and Perak, 50 ♀♂ (I.M.R.).

Paratypes have been placed in the British Museum, together with Malayan specimens with corresponding larval and pupal skins.

Up to now this form has generally been confused with var. *hackeri*. Edwards (1921), in his description of *hackeri*, notes an exceptional specimen of Roper's with broad apical pale bands on the palps, and, partly on account of this specimen, gives *hackeri* only varietal rank. This specimen, which I have examined, belongs to var. *pujutensis*.

Specimens of *pujutensis* have been seen from the Malay Peninsula, British and Dutch Borneo and Sumatra.

Anopheles leucosphyrus var. *hackeri* Edwards, 1921.

So far, specimens of this form have been seen only from the Malay Peninsula, which is the type locality, and from Pulau Laut, south-east Borneo. The few specimens of *leucosphyrus* from the Celebes which have been seen, and which included three females, were rather distinct, but are possibly more closely related to *hackeri* than to any of the other forms. The palps are exactly like those of *hackeri*, shorter than the proboscis, and with very narrow apical and

subapical pale bands, but the dark marks on vein 1 tend to have numerous pale interruptions, e.g. 3–6 in the preapical dark mark instead of only one as in typical *hackeri*. Also the dark stripe on the hind tibial pale band tends to be divided, taking the form of a short proximal stripe with a disconnected black spot distally.

The characters attributed to var. *hackeri* by King and Baisas (1936 : 88) in their key are at variance with those of var. *hackeri* as understood here, and would seem to be more applicable to *pujutensis* and the Celebes form.

Type : ♀ in Brit. Mus. (Nat. Hist.).

Specimens seen : Malay Peninsula : Numerous specimens (B.M., L.S.H.T.M., I.M.R.). Borneo : South-east coast, Pulau Laut, 9 ♀ (*Leopold*) (A.). Celebes : Variant form : Aalo, Kaboena, Boeton, 1937, 2 ♀ (*Brug*) (B.) ; Lindoe Meer, 1000 m., 1937, 1 ♀ (*Arug* and *Tesch*) (B.) ; ♂♂ from both localities probably this form.

Anopheles leucosphyrus var. *elegans* James, 1903.

Nine females and two males of this form have been seen ; six of the females and the two males were some of Cogill's original specimens from the type locality, Karwar, south India (Cogill, 1903), on which James' description is based (James *in* Theobald, 1903 : 51). Of the remaining three females, one is from Travancore, south India, and two, rather damaged, but apparently of this form, are from Ceylon. The form appears to be close to *hackeri*, but differs as indicated in the key, and in other respects ; in particular the relative lengths of the palps, proboscis and fore femur appear to distinguish it from *hackeri* (data to be published later).

Christophers (1933) describes a discontinuous distribution for *leucosphyrus* in the Indian area : on the west coast region of India, and then in Burma, Assam, Bengal and the Andaman Islands in the east. It may be that *elegans* is confined to this western area which would appear to include Ceylon.

Investigation reveals a rather complicated situation in regard to the name *elegans*. James sent one specimen with his manuscript description under the name *elegans*, and a drawing of a wing, to Theobald, who promptly published the description and the drawing, designating the single specimen as the type of *A. leucosphyrus* var. *elegans* James (Theobald, 1903 : 51).

Christophers (1933), following Theobald, states that the type of *elegans* is in the British Museum. There is in fact no specimen labelled as type, but there is one of which the collection data agree with those given by Theobald (Karwar, April, 1902) and this is presumably Theobald's specimen. The other specimens are labelled September and October, 1902, which agrees with Cogill (1903) who states that he found only two larvae in April and the rest not until September, after the rains. Unfortunately, this single April specimen, though rather shrivelled, is apparently of the type form, having more than one division in the preapical dark mark and the presector one divided ; it is not the same as the remainder of the specimens which are clearly those to which James' description applies.

James and Liston (1904) published the same description and figure as Theobald (together with additional figures and information), but stated that the figure in question (p. 83) represented a variant specimen. Their figure on plate 12 represents the normal type of wing, and agrees exactly with the

specimens seen, except that it shows a small dark mark on vein 1 proximal to the presector dark mark ; there was only one specimen with a few scales in this position . In accordance with the figure their description states that " the first longitudinal vein shows seven dark-scaled areas of different sizes arranged as shown in the diagram." It would appear that there are normally six ; the figure of the variant wing shows eight, and the wing of the April specimen has nine. The significance of this is that the figure of the normal type agrees with the specimens in showing a wing like that of var. *hackeri* with only one division in the preapical dark mark, whilst the figure of the variant wing shows more than one division in this mark, as in the type form of which the April specimen is an example (see key).

It may be mentioned, incidentally, that whilst James and Liston's figure of the normal wing accurately depicts a common distribution of pale fringe spots, in particular one at the termination of vein 5·2 and one between 5·2 and 6, they state in their description that there is a fringe spot at the end of each vein, and this is shown in the figure of the variant wing. I have not seen a fringe spot at the termination of vein 6 in any form in the *leucosphyrus* group.

Cogill (1903), who also describes his specimens, correctly mentions that the proboscis of the female is slightly longer than the palps.

It seems, therefore, that Theobald was in error in designating the April specimen as the type of var. *elegans* James, and it is clear that the description given by James and Liston, despite minor discrepancies, refers to the bulk of the specimens, collected by Cogill in September and October, 1902, eight of which I have seen.

Variety *elegans* was sunk as a synonym of *leucosphyrus* by James and Stanton (1912), but if, as seems probable, it is a distinct form, the name *elegans* should be revived.

Types : In Brit. Mus.

Specimens seen : India, S.W. : Karwar, N. Kanara, 9.x.1902, 6 ♀, 2 ♂ (*H. Cogill*) (4 ♀, 2 ♂ in B.M., 2 ♀, L.S.H.T.M., in cavity slides) ; Travancore, 1934, 1 ♀ (Iyengar) (L.S.H.T.M.). Ceylon : Kapitigalla, 1921, 1922, 2 ♀ (*R. Senior-White*) (B.M.).

A. leucosphyrus Dönitz, 1901, and var. *balabacensis* Baisas, 1936.

Dönitz described *leucosphyrus* from several specimens from Kajoe Tanam, Sumatra ; he sent one specimen to Theobald which the latter (1901 : 307) described. In the British Museum there is an old broken specimen labelled in pencil, possibly by Dönitz himself, "*A. leucosphyrus* Dö Sumatra. K.T.," which is presumably this specimen ; K.T. probably standing for Kajoe Tanam. Fig. 2 is a sketch of one wing of this specimen which shows a pattern common for this form, the important point being that the presector dark mark is divided and there is more than one division in the preapical (see key). Dönitz (1902 : pl. I, fig. 7) gives a photograph of a wing of *leucosphyrus* from Kajoe Tanam, which is reproduced slightly altered by Theobald (1903 : 53). Dönitz's photograph shows the preapical dark mark with three divisions. The basal part of the wing is not in sharp focus so that one cannot say what is the condition of the presector dark mark.

It seems therefore that this specimen in the British Museum can be regarded

as a cotype. The abdomen is distended with dried blood, which suggests that it, and probably the whole series from Kajoe Tanam, may have been captured resting indoors after biting, which may be significant (see discussion on the vector form, p. 50).

The principal diagnostic features of this type form, so far as they are known at present, are indicated in the key. The number of divisions in the presector and preapical dark marks is variable, and sometimes on one wing there may be only one in the preapical. This tendency to reduction in the number of divisions in the preapical dark mark has been noticed in specimens from Assam. However, apart from the *hackeri*-like form from Celebes (p. 45) this type form appears to be the only one with a divided presector dark mark on vein 1.

King and Baisas (1936) and Russell and Baisas (1936 : 38), provisionally treat the form from Luzon and Mindanao as belonging to the type form ; this would seem to be correct as it had the principal characters of the type form, though lacking the basal pale band on hind tarsus four. King and Baisas

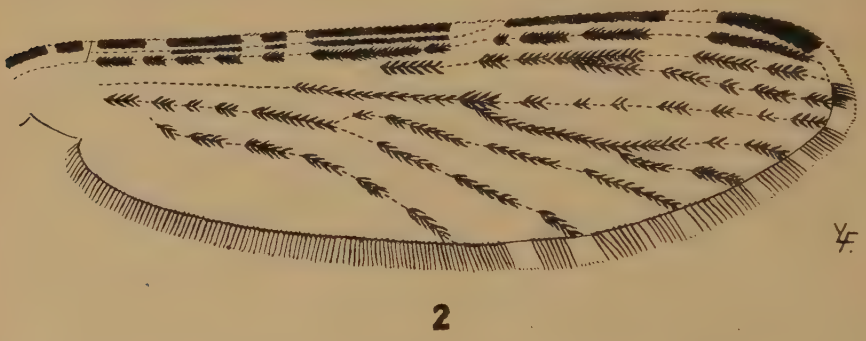


Fig. 2.—Sketch of the wing of a presumed cotype of *leucosphyrus* Dönitz in the British Museum.

note the reduced tarsal banding as compared to specimens from Borneo. But Baisas (1936) then separates specimens from Palawan as variety *balabacensis* Baisas, which differs from the Luzon specimens principally as follows :

Hind tarsus four usually with a basal pale band, pale bands of fore tarsi usually complete beneath ; costa often with an accessory sector pale spot. Larva with palmate hairs of abdominal II moderately well developed . . . . . var. *balabacensis*.
Hind tarsus four without basal pale band, pale bands of fore tarsi not complete beneath ; costa less often with accessory sector pale spot. Larva with palmate hairs of abdominal II rudimentary . form from Luzon.

But all these characters of *balabacensis*, except perhaps that of the larval palmate hairs, are also characters of the type form as represented by specimens from Sumatra and Borneo, and it is doubtful whether adults of *balabacensis* could, in general, be distinguished from those of the type form. The differences between the latter and the Luzon form are almost certainly examples of geographical variation. The closer resemblance between the type form from Sumatra and Borneo and var. *balabacensis*, than between the former and the

Luzon form, is only to be expected since Palawan is nearer the centre of the range of the type form than is Luzon, and has a fauna which is more closely allied to that of Borneo than that of the Philippines (Scrivenor *et al.*, 1943, pp. 141, 148, etc.).

In these groups of closely allied and morphologically very similar forms (sibling species of Mayr, 1942), it does not seem desirable to name what appear to be only geographical variations of one form, until we have distinguished the forms which occur side by side in the same region (sympatric species of Mayr). The comparative scarcity of well substantiated geographical races (subspecies) in *Anopheles* may be largely due to the fact that we have only recently begun to detect these closely similar forms (sibling species) which occur together in the same or widely overlapping regions. Until these are described we can hardly hope to make much progress in the study of geographic variation in *Anopheles*. In this connection see Bates (1940) on *A. maculipennis*, and comments on his paper by Mayr (1942).

It would seem best, therefore, for the time being to sink the name *balabacensis* as a synonym of *leucosphyrus* type form. When much more material, including the immature stages, has been examined, and the group is better understood, we shall most probably recognize the sympatric forms as full species, as has been done in the case of *A. maculipennis* (Bates, 1940) and the *punctulatus* complex (Rozeboom and Knight, 1946). The form from Luzon might then be found to be a subspecies (geographical race) of *leucosphyrus sensu stricto* (= type form) and could be named accordingly.

The " Spine IV long " pupal type of Crawford (1938) corresponds to the type form.

Specimens of the type form have been seen from Karwar (see p. 47), and Duars, Bengal, in India ; Andamans, Assam, Burma, French Indo-China, Philippines (both Luzon and *balabacensis* forms), north and south Borneo, Sumatra and the Malay Peninsula.

Types of *leucosphyrus* : ? non-existent. Cotype : ♀ in Brit. Mus.

Types of var. *balabacensis* : ♂♀ in Bureau of Health, Manila, ? still extant.

Specimens seen : INDIA : 1930, 1 ♀ (*Christophers*) (L.S.H.T.M.) ; Karwar, iv.1902, 1 ♀ (*H. Cogill*) (B.M.) ; Bengal, Jalpaiguri, 1907, 1 ♀ (*C. Wallich*) (B.M.), 1933, 1 ♀ (*B. M. Khan*) (L.S.H.T.M.). ANDAMAN ISLANDS : 1908, 1 ♀, 1 ♂ (*Ray White*) (B.M.). ASSAM (L.S.H.T.M.) : Tura, 1934, 5 ♀ (Assam. Med. Res. Soc.) ; Juri, Sylhet, 1937, 5 ♀ (*Hamilton*) ; Lebac Cachar, 1934, 1 ♀ (*C. Frazer*). BURMA (L.S.H.T.M.) : 1 ♀ (*T. T. Macan*) ; Kabaw Valley, 1944, 2 ♀, 1 ♂ (*T. T. Macan*). FRENCH INDO-CHINA : Laos, 1932, 1 ♀ (*C. Toumanoff*) (B.M.) ; Suzannab, 1 ♀, 2 ♂ (*Borel*) (P.). MALAY PENINSULA (I.M.R.) : Selangor, Kuala Kubu, iv.1941, 2 ♀, 3 ♂, Gombak, iii–iv.1934, 3 ♀ ; Negeri Sembilan, Gemas, iii.1946, 1 ♀. SUMATRA : K.T., 1 ♀ (? cotype) (B.M.) ; Deli, 15 ♀ (B.) ; Mandailing, 1 ♀ (B.). BORNEO : North, Membakut, 1913, 7 ♀ (*R. Roper*) (2 B.M., 5 L.S.H.T.M.) ; Sarawak, Bidi, 1906, 2 ♀ (*J. C. Moulton*) (B.M.), Quop, 1906, 1 ♀ (*J. C. Moulton*) (B.M.), Miri, 1927, 1 ♀ (*V. A. Stookes*) (L.S.H.T.M.) ; East, Balek Papan, 2 ♀, ♂♂ (B.) ; S.-East, Pulau Laut, 6 ♀ (*Leopold*) (A.). PHILIPPINES (B.M.) : Los Banos, 1930, 1 ♀ (*P. F. Russell*) ; Balabac Island, 1934, 1 ♀, 1 ♂ (*P. F. Russell*) ; Palawan Island, Iwahig, 1934, 1 ♀ (*P. F. Russell*).

Anopheles cristatus King and Baisas, 1936.

This form, though similar to var. *riparis* in the adult stage, has distinctive larval characters ; in particular the posterior clypeal hairs are large and strongly branched. There is only one adult specimen in the British Museum, but that is a very small insect and has much the shortest proboscis, relative to the fore femur, of any specimens measured.

Types : ♀♂ in U.S. Nat. Mus.

So far known only from the Philippines.

Anopheles leucosphyrus riparis King and Baisas, 1936.

The form of *leucosphyrus* which seems to be commonest in collections from Malaya, and which is Crawford's " Spine IV short " pupal type, is evidently the same as variety *riparis*. No Philippine material was available, but Malayan specimens agree in all important respects with the description of *riparis*. There are, however, minor differences, and as with the type form, it is evident that geographical variation occurs. For example, in the female of the Philippine *riparis*, the accessory sector pale spot usually extends onto the costa ; the male is said to be the same. But in Malayan *riparis* there is rarely (1/20) any accessory sector pale spot on the costa in the female, though it is common in the male (7/10). There seems to be less speckling on tarsus 1 of the mid leg in Malayan *riparis* than in specimens from the Philippines, where this speckling is used as one character for distinguishing *riparis* from *cristatus*.

Types : ♀♂ in U.S. Nat. Mus.

So far specimens have been seen only from the Malay Peninsula. The type locality is Mindanao, Philippine Islands.

Specimens seen : Malay Peninsula : Various localities, numerous specimens (B.M., L.S.H.T.M., I.M.R.).

4. Evidence for Suspecting the Type Form to be a Vector of Malaria.

In 1941 Dr. J. McArthur, who was working at Tambunan in the interior of British North Borneo, and was in correspondence with this Institute, reported that he had found a high glands infection rate in *leucosphyrus*, and sent specimens (McArthur, 1947). These were examined by the writer, and this led to his study of the *leucosphyrus* group.

McArthur's specimens were all of the type form. At about the same time nearly 400 *leucosphyrus* were caught in a human bait mosquito net trap, operated for about 17 nights in all, at two places on the Malaya-Siam border, by No. 6 Anti-Malarial Unit (O.C., Captain Kuraishy, I.M.S.). On one night, whilst the trap was located in a new clearing in the jungle, 163 *leucosphyrus* were caught, many of them having fed on the men operating the trap. A few dissections were made, but the results were inconclusive. On another night when the writer was present, 22 were caught ; all of these, and all other specimens seen by him were of the type form. The trapping of numbers of *leucosphyrus* in Malaya was a new and exciting event, but the Japanese invasion put a stop to any further investigations.

Recently, a few specimens from Assam and Burma in the collection of the London School of Hygiene and Tropical Medicine (details on p. 49) have been examined and all were found to be the type form. This is interesting because

Clark and Choudhury (1941) proved *leucosphyrus* to be a vector in upper Assam, and the British and American Forces (McArthur, 1947, editorial footnote, p. 558) found the same to be true in Burma. Macan, who collected the specimens from Burma referred to above, informs me in a letter that *leucosphyrus* was regarded as the principal vector of malaria during the wet season in the Kabaw Valley of Burma from which his specimens came.

The writer, whilst a prisoner of war, encountered *leucosphyrus* in Siam in June and July, 1943, during the wet season, in the Me Nam Kwe Noi Valley near the Burma border. Unfortunately, the exact form could not be determined and specimens were not kept, but the breeding places were like those usually chosen by the type form.

Roper (1914), in North Borneo, reported finding blood-fed *leucosphyrus* inside his patients' mosquito nets in the mornings. Ten of his specimens have been examined ; seven were the type form, and three were var. *pujutensis*, but it is not known whether these ten were collected from the mosquito nets or not.

There is no point in labouring this somewhat flimsy evidence further, but so far as it goes, it suggests that it is the type form which has been found infected in the recent investigations quoted, and that this form bites man readily ; it has not yet been shown that any of the other forms do so. What is required now is further trapping and dissection of *leucosphyrus*, taking care to identify the form to which each specimen belongs before dissection.

5. Breeding Places of the Larvae.

Morphological differences between the larvae and pupae of these forms of *leucosphyrus* are only imperfectly known as yet, and for that reason, apart from a few remarks in the preceding pages, they are not discussed here. It is hoped to deal with them at a later date.

Differences in preferred larval breeding places are also largely undefined as yet, but one can say that it seems as if the larvae of the type form are often found in somewhat temporary breeding places, such as rain water in elephant tracks and wheel ruts, often in rather open jungle. Variety *riparis*, on the other hand, tends to frequent streams, being often found in still pools in the rocky beds of small streams in jungle, or under dense rubber. Variety *hackeri* seems to be found as usual under shade, but there almost solely in such places as in fallen split bamboos, pools on rotten logs, and on the coast, in collections of water in the bases of Nipah palms (*Nipah fruticans*). Variety *pujutensis* is occasionally found along with *hackeri*, but occurs more frequently in small pools and other such places, not unlike those commonly chosen by the type form. In collections from Selangor, Malaya, only *hackeri* and *pujutensis* have so far been found associated with the brackish water zone.

6. Summary.

1. Apart from earlier records (Covell, 1944) which did not attract much attention, *Anopheles leucosphyrus* has recently been proved a vector of malaria in Assam (Clark and Choudhury, 1941), Burma (Covell, 1944), and Borneo (McArthur, 1947), and it is therefore important to clarify the systematics of the species.

2. The species appears to consist of at least six or seven distinct forms, four of which are known to occur in the Malay Peninsula. A tentative key to the adult females of these forms is given.

3. Notes are given on the nomenclature, identification and known distribution of these forms, one of which is identified, by examination of a probable cotype in the British Museum, as the type form of Dönitz.

4. The question of geographical variation and closely allied species in *Anopheles* is briefly discussed (p. 49).

5. The two types of pupae of Malayan *leucosphyrus* described by Crawford (1938) are identified. The " Spine IV long " form produces adults of the type form, and the " Spine IV short " form those of var. *riparis*.

6. Evidence is given which, so far as it goes, points to the type form as the one which has been found infected recently.

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A NEW SPECIES OF THE GENUS *NYCTERIBOSCA* FROM AFRICA (DIPTERA, STREBLIDAE).

By B. Jobling, F.R.E.S.

(Wellcome Entomological Field Laboratories.)

Nycteribosca longiarista sp. n.

In its general appearance this new species slightly resembles *Nycteribosca alluaudi* Falcoz, from which it differs by its larger size, chaetotaxy of the thorax, narrow palps and by the very long arista of the antennae. By the last two mentioned characters it is also easily separated from all the other species of the genus.

Body 3·5 mm. long (on slide). Head campanulate when examined from above ; anterior part of frons strongly produced, its anterior margin broadly rounded and has a very small notch in the middle ; laterovertices distinct, with four strong setae in the anterior part, near the inner margin, and a row of smaller setae along the antero-lateral margin, their other parts bear a few setae of varying length ; postvertex (vertical triangle) large, not well defined, without setae. Eyes small, not projecting beyond the lateral margin of the head. Arista of antennae very long, projecting beyond the terminal setae of the palps. Palps narrow, with fan-like arrangement of a few long setae at the tip. Theca of the labium (t.) large, conical, about twice as long as broad ; labella (l.) one-third of the length of the theca.

Thorax as long as broad, rounded anteriorly ; prescutum bears many small setae, and two longer ones directed more or less laterally, in the posterior half ; scutum with short setae in the anterior half and longer ones in the posterior half, besides it bears two very long setae in the middle ; scutellum triangular, with setae of different length, of which two arising in the middle are the longest setae of the mesonotum ; metapleura (met.) with small conical process. The ventral surface of the thorax beset with very small setae. Legs long ; the postero-dorsal part of the anterior femora and the antero-dorsal part of the middle and the hind femora with long setae, the rest of their surfaces bear short thin setae ; tibiae bear many very small setae, these are slightly longer along the inner side and more dense at the apex, where they form a darkly pigmented patch in the tibiae of the fore and especially in those of the hind legs.

Wings 3·2 mm. long, with rounded apex. The distal part of the first and second longitudinal veins sharply bent towards costal vein ; third and fourth longitudinal veins slightly divergent near the apex of the wings ; the basal part of the third longitudinal vein angular ; costal margin of the wings with short setae ; marginal, submarginal and posterior cells moderately setose. Apical part of alula narrowly rounded. Halteres presenting no distinctive character.

Abdomen with a row of a few strong setae on each side of its bare dorsal surface, and much shorter setae laterally to these ; its ventral surface beset with small setae. Ventral plate of the abdomen more or less triangular, it bears many small but stout spine-like and two long marginal setae. Apical cone of the abdomen with six long dorsal and six slightly shorter ventral setae.

For the specimen of this new species I express my thanks to Mr. T. S. Jones, of the Department of Agriculture, Sierra Leone, W. Africa, who has found it together with one *Nycteribosca africana* Walker, two *Raymondia*

huberi Frauenfeld, and one *Cyclopodia* sp., on *Hipposideros caffer* Sundervall, in Makeni, Sierra Leone, W. Africa, 12.xi.1946. The type is preserved in the author's collection.

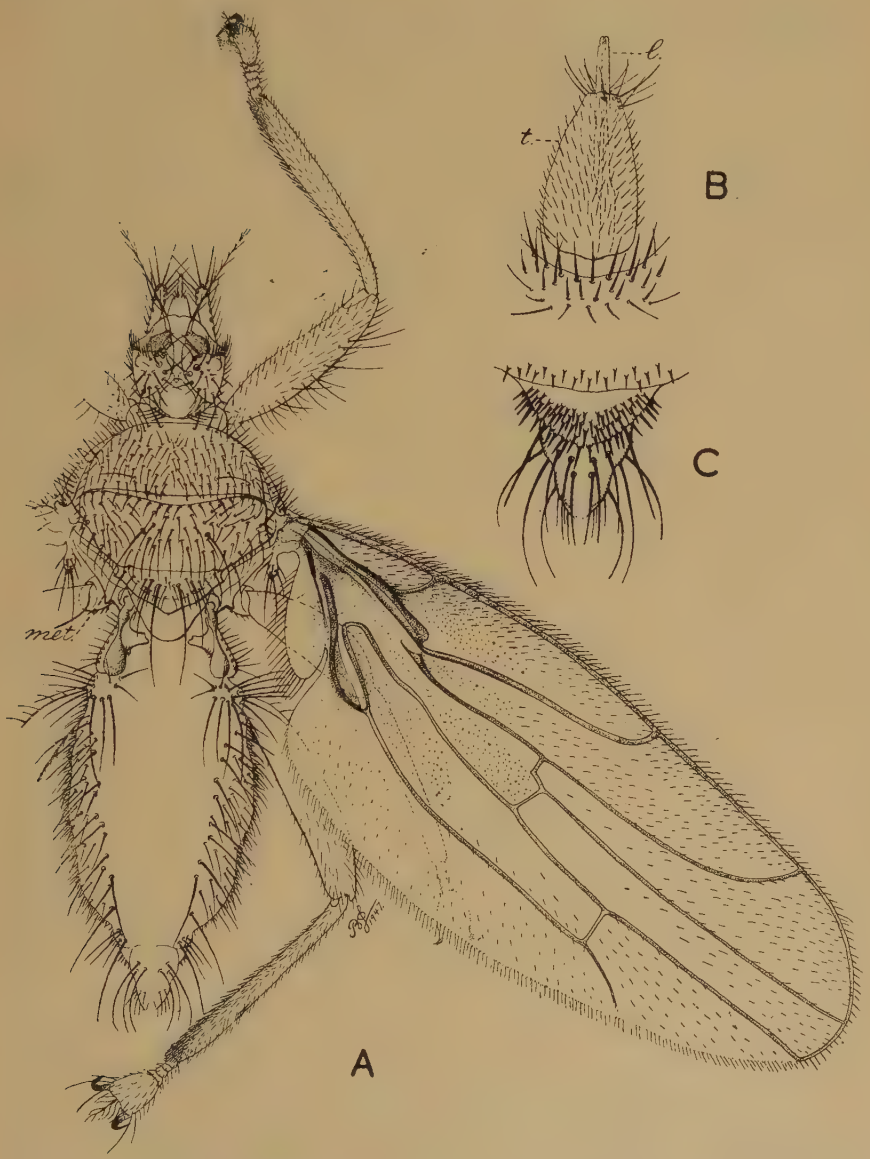

FIG. 1.—*Nycteribosca longiarista* sp. n. A, dorsal view of female; B, ventral view of labium; C, ventral plate and apical cone of abdomen.

THE CLASSIFICATION OF *GLOSSINA MORSITANS* WESTWOOD DIPTERA, MUSCIDAE, INCLUDING A DESCRIPTION OF A NEW SUBSPECIES, VARIETIES AND HYBRIDS.

By F. L. Vanderplank, Ph.D.

(1) A New Sub-species of the Tsetse Fly, *Glossina morsitans* Westwood.

During the course of an extensive series of experiments in the cross-breeding of *G. swynnertoni* Austen, collected at Shinyanga, Tanganyika, with *G. morsitans* Westwood collected at Kondoa Irangi, Tanganyika (Vanderplank, 1945 and 1947) it was thought desirable to see whether the results obtained from cross-breeding these two species would hold if one or both of the species were collected from different localities. Since it was not feasible to obtain supplies of *G. swynnertoni* from another locality, the Shinyanga *G. swynnertoni* were mated and cross-bred with *G. morsitans* from Kingolwira (Morogoro), Tanganyika. It was noted immediately that these "*morsitans*" mated more readily with *swynnertoni* than their own species and were somewhat reluctant to mate with *G. morsitans* from Kondoa Irangi. After quite extensive cross-breeding experiments which have been described in detail elsewhere (Vanderplank, 1945, 1947*a* and *b*) it was found that the Kingolwira species is genetically about mid-way between *swynnertoni* and Kondoa *morsitans*.

These facts led to an extensive study of the external morphology of these and other species, also further breeding experiments. *G. morsitans* from Ankole, Uganda, were crossed with *G. morsitans* from Kondoa Irangi and *G. morsitans submorsitans* (Newstead) from Kaduna, Nigeria, with the result that *G. morsitans* from Ankole and those from Kondoa Irangi mated and bred, showing no signs of preference or sterility, but when *G. submorsitans* was cross-bred with either, preferences were shown, and all male offspring were sterile.

The new subspecies from Kingolwira had abdominal and male genitalia markings similar in many ways to *G. morsitans submorsitans* and, but for its distribution, might be an intermediate form between the latter and typical *morsitans*. It has not been possible to obtain living *morsitans* from Kingolwira and *submorsitans* together at the same time, and so far not possible to attempt to cross-breed them. A few *submorsitans* have been mated with *swynnertoni*, and these only mate very reluctantly. None of the cross-inseminated females produced full-term offspring. This, together with its geographical distribution, is sufficient evidence to conclude that the Kingolwira species is not intermediate between *submorsitans* and typical *morsitans*, but more likely an intermediate form between typical *morsitans* and *swynnertoni*.

The next important question is the status of the Kingolwira species, whether it should be described as a race, subspecies or species. Although the breeding experiments show that it produces sterile male hybrids when crossed with typical *morsitans*, its distribution shows that it forms a cline with the latter. Similarly, a cline may still exist between typical *morsitans* and *submorsitans*. For this reason alone *submorsitans*, like *orientalis*, should be regarded as a subspecies of *morsitans* instead of a separate species.

Glossina morsitans **orientalis** subsp. n.

Measurements.—It is usual to give measurements of length, length of palpi, greatest width of head and wings. Such measurements have generally been based on a very small sample of flies, less than 10 in most cases. Even when samples of more than a hundred are measured, these give histograms which are significantly different from measurements of tsetses from a neighbouring area, or taken in a different season. Such measurements are quite useless for identification, or any other purpose beyond giving a general impression of the insect's size. The size of all tsetses varies greatly according to the season and environment; in the laboratory very small flies can be bred, and most laboratory-bred flies are smaller than wild individuals; high temperatures produce smaller individuals. Usually the size of *G. morsitans orientalis* is smaller than typical *morsitans* or *swynnertoni*, and similar to *G. mor. submorsitans*, but this is quite possibly due to the warmer climatic conditions of its environment. Variation in size is considerable and varies significantly from season to season and from locality to locality.

Head.—As for typical *morsitans*, *submorsitans* and *swynnertoni*.

Antennae.—Colour variable and similar to typical *morsitans*, *submorsitans* and *swynnertoni*.

Thorax.—Colour variable, slightly darker and more reddish than typical *morsitans*, but not so dark as *swynnertoni*.

Abdomen.—Dorsum in life is a dull, reddish brown; second segment with a blotch of dark brown and black at the posterior angles, dark brown area usually a relatively large oblique blotch, and a black area or spot at the posterior angles of each blotch. The interrupted transverse bands on the second to fifth segments vary, but are nearly always darker than typical *morsitans* and more definite; in some specimens, especially those from parts of Portuguese East Africa, they are identical with *swynnertoni*. The abdomen of this subspecies is very "hairy," far more so than any other subspecies or race in the *morsitans* group. The Kingolwira type is shown in Plate 1, fig. c, which has been coloured from the living specimens.

Male genitalia.—These are shown by the photograph in Plate 2, fig. A. They are similar to typical *G. m. morsitans*, but have one distinctive feature. The male genitalia of typical *G. m. morsitans*, together with those of *G. swynnertoni* and hybrids "*swynnertans*" and "*morsitoni*" have already been described by Vanderplank (1947). In typical *G. m. morsitans* the median lobes project from the inner sides of the superior claspers, and do not continue to form submedian right-angle plates as in *swynnertoni*. Newstead (1924) has already pointed out that the median lobes of *G. m. submorsitans* continue in a broad parallel-sided strip of pale chitin. In *G. m. orientalis* the median lobes do not join sharply to the superior claspers as in *G. m. morsitans*, but continue in a broad strip of pale chitin, which tapers into the superior claspers on its inner curve. So in this respect they have an intermediate appearance between *G. m. morsitans* and *G. m. submorsitans*. As already stated, the cross-breeding experiments have shown that *G. m. orientalis* is intermediate between *G. swynnertoni* and *G. m. morsitans*, and that *G. m. morsitans* is intermediate between *G. swynnertoni* and *G. m. submorsitans*. Patton (1936) failed to note any differences in the male genitalia of *G. m. morsitans* and *G. m. submorsitans*, and concludes they are merely eastern and western varieties of the same species. This conclusion is now invalidated by the cross-breeding experiments. Type genitalia and specimens are deposited with the British Museum (Natural History), and were collected at Kingolwira, Tanganyika.

Female genitalia.—Externally, these are similar to those of other members of the group. Recently longitudinal sections of the abdomen of females have revealed extensive morphological differences between such species as *G. swynnertoni*, *G. m. morsitans* and *G. m. sub-*

morsitans, Vanderplank (1947*b*), but up to the time of writing no suitable material of *G. m. orientalis* has been available for examination by this method.

Distribution.—The approximate distribution of *G. m. orientalis* and other subspecies of *G. morsitans* is shown in Map 1. The whole of the eastern *mor-*

Map 1.—Distribution of *G. morsitans.*

sitans belt in Tanganyika from Handani and Pangani in the north to Portuguese East Africa is bounded on the western side by the Central Tanganyikan highlands which form an absolute geographical barrier between *G. m. orientalis* and *G. m. morsitans*. The *morsitans* of Portuguese East Africa, Nyasaland and Southern Rhodesia also belong to this subspecies. Specimens from parts of Northern Rhodesia appear to be intermediate between *G. m. morsitans* and

G. m. orientalis. A continuous cline undoubtedly existed between the two subspecies in this area, Northern Rhodesia and Nyasaland, also through Zambesi Valley in Southern Rhodesia, in comparatively recent times, but from information available this cline is now severed in several places. Male genitalia of ten to fifty specimens from Handani, Pangani, Kilosa, Morogoro (Kingolwira), Utete, Lindi, various areas around Songea, Mahenge (all in Tanganyika) have been examined, also specimens from various localities in Portuguese East Africa, Nyasaland, Northern and Southern Rhodesia. I have also examined *G. morsitans* var. *pallida* Shircore and *G. morsitans* var. *paradoxa* Shircore in the British Museum. These both appear to be colour varieties of *G. m. orientalis*. As already pointed out, there is a considerable variation in size and colour from season to season and within each locality; these varieties do not appear to have any significance except as examples of colour variation.

Conclusions.

(1) Seasonal and environmental changes in *coloration* and *size* make these unreliable characters on which to base new races, species or subspecies, unless accompanied by other data.

In the absence of further evidence, *G. morsitans* var. *pallida* (Shircore) is merely a pale individual. *G. morsitans* var. *paradoxa* (Shircore) appears to be an abnormal *G. morsitans orientalis*. Numerous specimens from all localities in Nyasaland have been carefully examined and no unusual features found beyond normal variation of the species and that they all are *G. morsitans orientalis* rather than typical *G. morsitans morsitans*.

(2) *G. swynnertoni* is isolated from *G. morsitans orientalis*, but as a secondary advancement its territory now fringes on the habitats of *G. morsitans morsitans*, but owing to inability of the two species to recognize each other, cross-mating takes place with resultant sterility and prevents intermingling beyond an overlap of a few miles.

(3) The three sub-species of *G. morsitans* were recently linked by a continuous cline and there are intermediate forms. Although three separate subspecies can be recognized morphologically, and from cross-breeding experiments, they are not yet genetically separated enough to warrant specific status.

(2) Variations in the Male Genitalia of *G. m. submorsitans*.

During the course of an extensive study of the male genitalia (terminalia) of *G. morsitans* and its subspecies from as many localities as possible, it was found that *G. m. submorsitans* could be divided into three or four distinct varieties. Whether these are merely due to recent geographical isolation without any genetical significance, or are of sufficient importance to warrant the formation of several new subspecies, cannot be decided on morphological grounds. It would be most desirable to cross-breed them and see whether the offspring were sterile or partly so. So far it has not been possible to obtain living specimens from the various localities and so I have been unable to decide their exact status, and propose to describe them as races of *G. submorsitans* for the time being.

1. *G. morsitans submorsitans* race *ugandensis*.

Glossina morsitans collected in many localities of the North Uganda fly belt were found to have distinctive male terminalia. This belt is separated and isolated from the main *G. morsitans morsitans* belt from south of Uganda and the *morsitans* there have been described by Newstead (1924) as a mixture of typical *morsitans* and *submorsitans*. If this were so, interbreeding would occur between the two species, and as shown by the laboratory breeding experiments, the male offspring are sterile and the females partly so. If the two species were in contact together, one would expect the same state of equilibirum as occurs where *G. swynnertoni* and *G. morsitans* meet (see Vanderplank, 1947). The male genitalia of these Northern Uganda *submorsitans* are distinct from *submorsitans* as described by Newstead. In carefully flattened preparations (and care should be taken to flatten the specimens completely as otherwise it is easy to be misled by the variations due to perspective) the superior claspers (anal cerci) have a triangular appearance (Plate 2, photograph B), and have a very stout long bristle projecting from the middle of the exterior surface of each superior clasper. In *submorsitans*, as described by Newstead, and in those from Nigeria, a similar but smaller bristle arises from the outer edge near the rudimentary claw. The median lobes of this race are also distinctive; in flattened preparations they project well above the top of the superior claspers and have well defined apices. The two median lobes are " hinged " closely together by connective tissue, and, as in all *submorsitans*, continued as broad parallel strips of pale chitin following the inner edge of the superior claspers between the

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EXPLANATION OF PLATES.

PLATE 1.

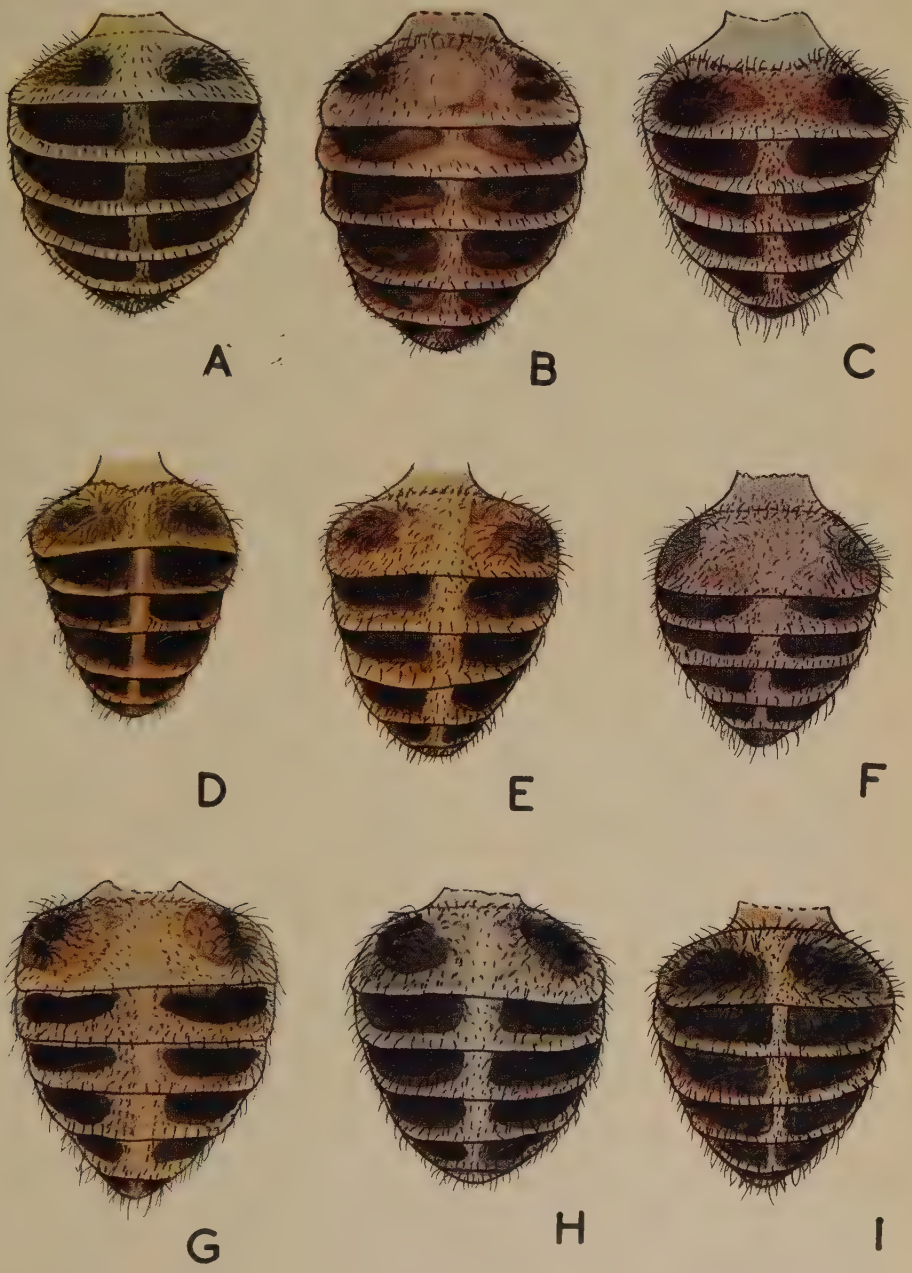
Abdomens drawn and coloured from living Tsetses. (A) *G. swynnertoni* from Shinyanga. (B) *G. morsitans morsitans* from Kondoa Irangi. (C) *G. morsitans orientalis* from Kingolwira. (D) *G.* "*swynnertans*." (E) *G.* "*morsitoni*". (F) *G.* "*orientalbrid*". (G) *G.* "*morsihybrid*". (H) Hybrid offspring of female *G. mor. morsitans* (Ankole, Uganda) crossed with male *G. mor. submorsitans* (Kadua, Nigeria). (I) *G.* "*swynnertans orientalis*".

PLATE 2.

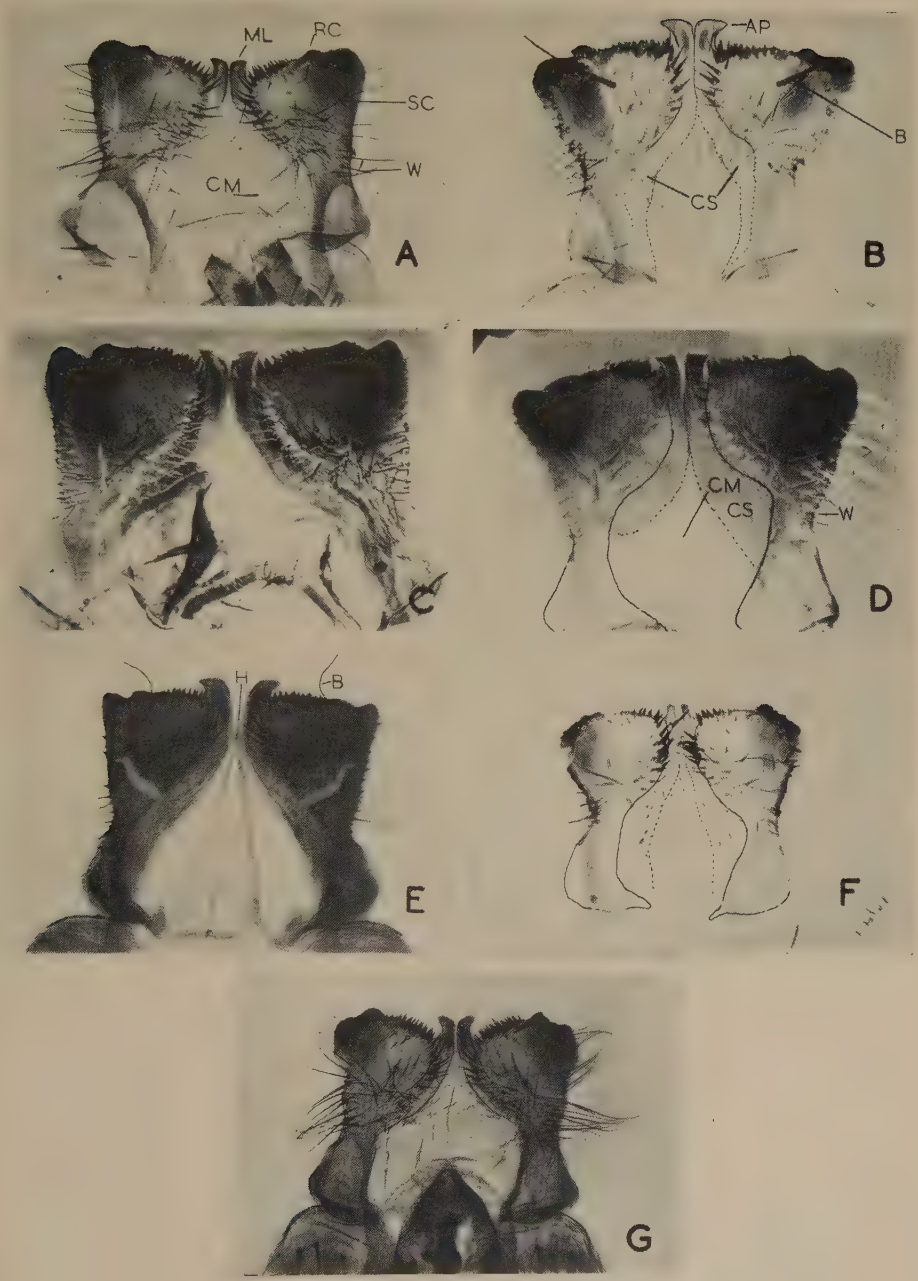
Male genitalia (terminalia). (A) *G. morsitans orientalis* from Kingolwira, Tanganyika. (Type.) (B) *G. m. submorsitans* race *ugandensis*, Nile area, Uganda. (Type.) (C) *G. m. submorsitans* race *congolensis*, Stanleyville, Belgian Congo. (Type specimen.) (D) *G. m. submorsitans* race *gambiensis*, Gambia. (Type specimen.). (E) *G. m. submorsitans* (Newstead), Kaduna, Nigeria. (F) Hybrid "*swynnertans orientalis*" (ex SK/series). (G) Hybrid "*morsihybrid*" ("C" cross ex IK/ series.) AP, apice; B, bristle; CM, connecting membrane; CS, chitinized strip; H, hinge of median lobes ML, median lobe; RC, rudimentary claw; SC, superior clasper or anal cerci; W, " waist."

PLATE 3.

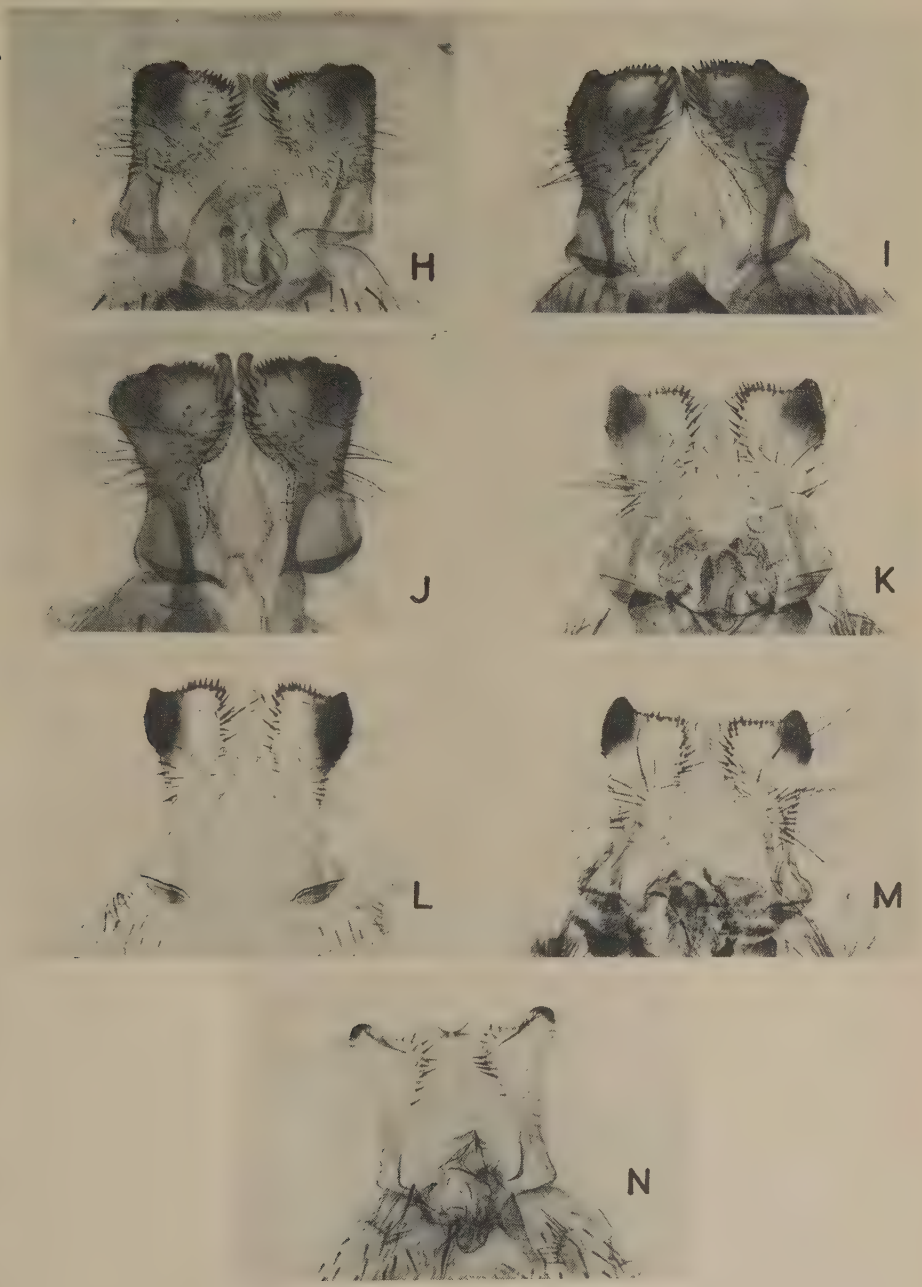
Male genitalia (terminalia). (H) Hybrid "*orientalbrid*" ("E" cross ex KI/series). (I) Second generation back-cross hybrid "*swynnertans orientalis*" (ex SV/series). (J) Second generation back-cross hybrid "*morsimorsihybrid*" (ex IC/series). (K, L) *G. pallidipes* from Whoima, Uganda, with " median lobes." (M) *G. pallidipes* from Mbulu, Tanganyika, with " median lobes." (N) Typical *G. austeni* from Kilifi, Kenya Colony.



F. L. Vanderplank. *Abdomens drawn and coloured from living Tsetses.*



F. L. Vanderplank. Male genitalia of *Glossina morsitans.*



F. L. Vanderplank. Male genitalia of *Glossina morsitans.*

lower portions in the connecting membrane or bladder. As already described by Vanderplank (1947*b*), the pressure of body fluid in this bladder manipulates the superior claspers, and the parallel strips of chitin would cause these to be manipulated at different angles from those of typical *G. morsitans*. Newstead (1924), in his map, shows this belt of *morsitans* to be continuous with the southern belt and to continue north-westwards across Africa. No exact information has been obtained as to how far north-westwards the belt continues, but it does not appear to be a continuous belt, but a series of isolated tsetse areas. (See map.)

2. *G. morsitans submorsitans* race *congolensis*.

Some 50 specimens collected by the late B. D. Burtt in the neighbourhood of Stanleyville, Belgian Congo, were examined and all showed similar distinctive features. The superior claspers are typically *submorsitans* and pointed at each outside extremity. This is shown in Plate 2, photograph C. The large bristles that arise near the rudimentary claw in typical *submorsitans* are absent in race *congolensis* ; the median lobes and their prolonged inner edges are typical of *submorsitans*, but distinctive in the manner in which a percentage of them are quite widely separated by the continuation of the connecting bladder between the two median lobes. In typical *submorsitans* the median lobes are hinged tightly together. The exact extent of the distribution of this race is not known, but it is isolated from the main belts of *G. morsitans* and *submorsitans*.

3. *G. morsitans submorsitans* race *gambiensis*.

The male genitalia of this race is shown in Plate 2, photograph D. The superior claspers are typical, but, like race *congolensis*, rather larger than typical *submorsitans*. The distinctive features of this race are that the median lobes, instead of continuing into two broad strips of pale chitin parallel to the inner edges of the superior claspers, broaden out into two wide plates, as in *G. swynnertoni*, but not angular, as in the latter. These are rounded and form part of the connecting bladder. Newstead (1924) shows *G. submorsitans* as one continuous belt on the West Coast of Africa ; if this is so, then this race is the northern extremity of a cline, but from examination of material received it would appear to be a separate and isolated race of *submorsitans*.

4. *G. morsitans submorsitans* (Newstead).

The typical race as described by Newstead is shown in Plate 2, photograph E. The median lobes are hinged at a point about mid-way off the inner curve of the superior claspers and the connecting bladder extends almost right up to this point. The photograph taken from a stained preparation clearly depicts the inner parallel strip of chitin which is a continuation from the median lobes. The coloration of the abdomen of living *G. submorsitans* from Nigeria is shown in Plate I, fig. H. Male genitalia of specimens of each of these races have been deposited with the British Museum for future reference.

Since coming to Nigeria I find that " *gambiensis* " is completely isolated by a wide gap from typical " *submorsitans*," as suggested above. Also that the " *submorsitans* " belt in Nigeria and other West African colonies is not continuous as suggested by the map, but a series of isolated belts in this area.

Discussion.

The above races of *G. m. submorsitans* may have little more than an academic value, demonstrating how, under geographical isolation, groups of animals tend to become distinctive; yet, on the other hand, these races may have acquired physiological and ecological variations and distinctions, together with their morphological changes. If such physiological and ecological distinctions have been acquired, then they may prove of practical importance when control methods, successful with one race, are applied to another; and may explain why there are often discrepancies between workers investigating the "same" species in widely separated localities.

(3) A Description of Hybrid Offspring from Crossing Various Subspecies of *morsitans* with Each Other.

Two hybrid tsetse flies, *G.* "*swynnertans*" and *G.* "*morsitoni*," together with their parental species, *G. swynnertoni* and *G. m. morsitans*, have already been described by Vanderplank (1947). Several other hybrid tsetses have now been bred in the laboratory, all of which have distinctive features. It is possible that such hybrids may be encountered in certain localities where two species border on each other in the field, and so it is desirable to have a written account available for reference. Several preparations of hybrid genitalia have been deposited in the British Museum and others will be as material becomes available. The abdomens of hybrid *swynnertans* and *morsitoni* are shown in Plate 1, figs. D and E.

1. Hybrid "*swynnertans orientalis*."

Produced from crossing male *G. swynnertoni* with female *G. morsitans orientalis*. External appearances and banding usually similar to *G. swynnertoni*, but some individuals were intermediate between the parents; however, none were typically *morsitans*. The abdomen is shown in Plate 1, fig. I. The male genitalia (Plate 2, fig. F) are similar to those already described for "*swynnertans*," resulting from crossing male *G. swynnertoni* with female *G. morsitans morsitans*, but the median lobes are longer and project well above the superior claspers, also they broaden out into two pale strips of chitin and then into two vertical plates of slightly chitinised connective tissue filling the area between the "waist" of the superior claspers. The photograph should be compared with that of "*swynnertans*" and parental species. It is doubtful whether one could distinguish a mixed collection of male genitalia of "*swynnertans*" and "*swynnertans orientalis*" with any degree of certainty.

2. Hybrid "*morsitoni orientalis*."

Result of crossing male *G. morsitans orientalis* with female *G. swynnertoni*. Coloration and abdominal markings generally similar to *swynnertoni*, but sometimes intermediate between the parents. The male genitalia are very similar to those already described for "*morsitoni*" offspring from crossing male *G. morsitans morsitans* with female *G. swynnertoni*. The only distinctive feature is that the strip of pale chitin from the median lobes is continued parallel to the inner edges of the superior claspers as in the male parental species.

3. Hybrid "*morsihybrid*" ("C" series from IK/cross).

Offspring from crossing male *G. morsitans morsitans* with female *G. morsitans orientalis*. Coloration and abdominal markings similar to male parent *G. m. morsitans*, but abdomen rather more 'hairy" and banding more definite (Plate 1, fig. G). Male genitalia are intermediate between those of both parents but would be difficult to distinguish from typical *G. morsitans orientalis* (Plate 2, fig. G).

4. Hybrid "*orientalbrid*" ("E" series from KI/cross).

Offspring from crossing male *G. morsitans orientalis* with female *G. morsitans morsitans*. Coloration and markings similar to, but abdomen not so "hairy" as male parent (Plate 1, fig. F). The banding is not so dark and definite as in *G. m. orientalis*, but more definite than in *G. m. morsitans*. The male genitalia are similar to maternal species, but have some intermediate characters. The median lobes do not project from the superior claspers as in *G. m. morsitans*, but are attached to two right-angular submedian plates of non-chitinized connective tissue covered with minute external bristles. (Plate 3, fig. H).

5. Crosses between *G. morsitans morsitans* and *G. m. submorsitans*.

The offspring of these crosses all have the external coloration and markings similar to typical *G. m. submorsitans* (Plate 1, fig H). Very few male genitalia have been examined to date; these were intermediate in character between the two species, but the *submorsitans* features tend to be dominant.

Second Generation Back-crosses.

1. Hybrid "*swynnertans orientalis*."—Offspring produced by back-crossing a male *G. swynnertoni* with a female hybrid *G.* "*swynnertans orientalis*." External appearance and marking identical with the male parent *G. swynnertoni*. The male genitalia, however, are distinctive (Plate 3, fig. I). The superior claspers have a very marked triangular shape and narrow "waist." The median lobes are tapering and *swynnertoni*-like at their extremity, but broad between the two superior claspers, where they are "hinged" by connective tissue. They continue in a strip of pale chitin parallel to the inner edges of the superior claspers as in *G. m. submorsitans* and have numerous relatively long spines attached to the marginal strip of chitin. These genitalia are distinctive from other hybrids and parental species.

2. Hybrid "*morsimorsihybrid*."—Offspring from back-crossing a male *G. m. morsitans* with a female *G.* "*morsihybrid*" (of which a small percentage are fertile). This second generation back-crossed has the appearance and coloration of a typical *G. m. morsitans* and its male genitalia (Plate 3, fig. J) are practically the same as typical *G. m. morsitans*, but there is a narrow strip of pale chitin parallel to the inner edges of the superior claspers. These characters are insufficient to diagnosis a hybrid in the field, and similar forms are met with in *G. morsitans* in Northern Rhodesia and parts of Nyasaland, where the two subspecies merged together in the recent past.

Summary.

Part 1.—A new subspecies of *Glossina morsitans*, namely, *G. morsitans orientalis*, is described, together with its distribution.

Part 2.—Three new varieties or races of *G. morsitans submorsitans* are described, namely, var. *congolensis*, var. *ugandensis* and var. *gambiensis*. These races are geographically isolated from each other, and their approximate distributions are given.

Part 3.—Five hybrid offspring from crossing *G. morsitans orientalis* with *G. swynnertoni* and *G. m. morsitans*, and *G. m. morsitans* with *G. m. submorsitans* in the laboratory are described. Two types of second generation hybrids produced by back-crossing female hybrids with parental males are described.

Acknowledgments.

I wish to thank Professor P. A. Buxton, C.M.G., F.R.S., for help and encouragement with the above work; Dr. F. I. van Emden for his assistance and facilities at the British Museum ; and also Professor J. E. Harris, of Bristol, in whose Department most of the work was undertaken.

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VARIATION IN THE MALE GENITALIA OF THE TSETSE FLY *GLOSSINA PALLIDIPES* (AUSTEN) AND A NOTE ON *G. AUSTENI* (NEWSTEAD).

By F. L. Vanderplank, Ph.D.

Glossina pallidipes was first described by Austen in 1903 and *G. austeni* by Newstead in 1912, and both species are classed as members of the *morsitans* group. *G. pallidipes* has variable abdominal markings and coloration, and these tend to vary with the season and locality. It is very similar to the West African species, *G. longipalpis*, and I doubt whether it is more than a subspecies of the latter, which was first described by Weidemann in 1830. During the course of the last five years I have been able to examine several hundreds of specimens from different localities, and also to carry out a few cross-breeding experiments. These reveal various interesting variations in the male genitalia.

Distribution.

G. pallidipes is widely distributed in Somaliland, Ethiopia, (Sudan ?), Uganda, Kenya, Tanganyika, Zululand, Nyasaland, Northern and Southern Rhodesia, Bechuanaland and possibly the eastern districts of the Belgian Congo. In West Africa *G. longipalpis* is well distributed in numerous territories from Angola to Senegal. Both species inhabit thickets in savannah and forest country, also thickets fringing on rain forest areas. Although so extremely widespread, more so than any other species, its distribution is not continuous, but is broken up into very numerous isolated groups.

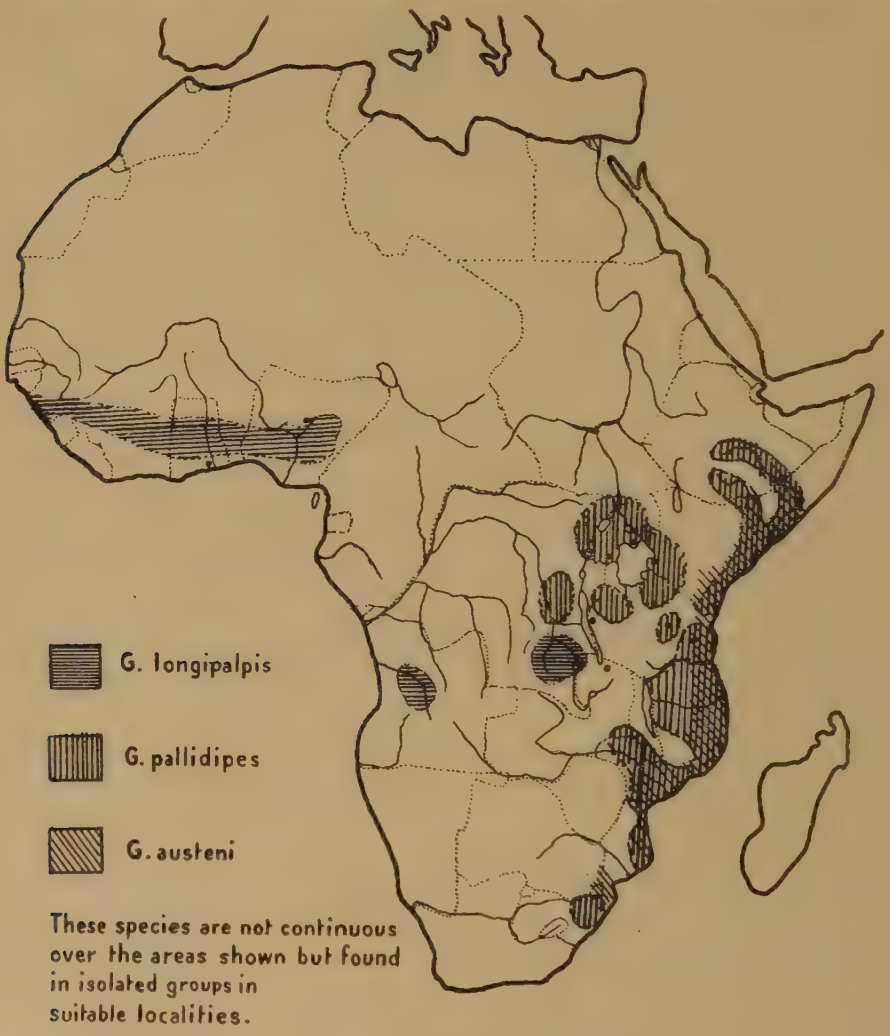
Geological evidence suggests that Africa has been subjected to a series of wet and dry ages, coinciding with the Ice Ages and Interglacial Periods of the northern and southern hemispheres. If this is so, there must have been a succession of vegetational changes. It is possible that during the last " Wet Age " conditions were such that *G. longipalpis* was able to spread all over Africa, but as conditions became drier it became separated into two parts, east and west, by changes taking place in the bridges over the natural geographical barrier of mountains and lakes running from north to south in Central Africa. One possible bridge for the continuous distribution of *G. longipalpis-pallidipes* is north of this barrier, another between Lake Tanganyika and Lake Nyasa, but at the present time *G. longipalpis-pallidipes* have been gradually isolated into very numerous groups.

Individuals from these various isolated groups have been studied for morphological variations, and a few cross-breeding experiments have been carried out.

Cross-breeding experiments.

Pupae of wild *G. pallidipes* can only be found in small numbers at certain seasons ; this is generally towards the end of the dry season, when few suitable breeding grounds remain and the pupae are concentrated into such places. So far I have only been able to obtain pupae from three areas : (1) Shinyanga, Tanganyika ; (2) Kisii, Kenya; and (3) Kingolwira, Tanganyika, and then only small numbers at the same time. Table I shows the numbers from each locality that were mated with each other ; in all 120 pairings were carried out ; of these 89 lived long enough to reproduce and were found to have been inseminated at death (Table II). Only 79 produced one offspring

or more. There are no significant differences between the results from any of the crosses. Both male and female first generation have been found fertile, so no marked genetical changes have yet taken place amongst these isolated groups. I had hoped to procure living *G. longipalpis* from West Africa and cross-breed these with *G. pallidipes*, but so far this has not been possible.


G. longipalpis
G. pallidipes
G. austeni
These species are not continuous over the areas shown but found in isolated groups in suitable localities.

Map 1.—Distribution of *G. longipalpis*, *G. pallidipes* and *G. austeni*.

Table I.—*Number of* G. pallidipes *from Various Localities Cross-mated with Each Other.*

Males from	Females from		
	Kingolwira.	Kisii.	Shinyanga.
Kingolwira	15	5	12
Kisii	3	20	10
Shinyanga	17	8	30

TABLE II.—*Number Surviving 21 Days and Found to have been Inseminated at Death.*

Males from	Females from— Kingolwira.	Kisii.	Shinyanga.
Kingolwira	12	4	9
Kisii	3	19	9
Shinyanga	11	7	25

TABLE III.—*Number of Females that Produced One Pupa or More.*

Males from	Females from Kingolwira.	Kisii.	Shinyanga.
Kingolwira	9	2	6
Kisii	2	10	6
Shinyanga	10	5	19

Variations in Male Genitalia.

As already stated, the markings and coloration of *G. pallidipes* vary considerably from season to season, and within each group, also between the groups; but the variations between the groups overlap very considerably with each other. Photographs of typical male genitalia of *G. pallidipes* from Shinyanga, Tanganyika and *G. longipalpis* from the Belgian Congo have already been published by Vanderplank (1947). Newstead (1924) gives a comparative table of the morphological characters of the two species. These are: (*a*) Tooth or rudimentary claw terminal and taking the same contour as the outer margin in *longipalpis*. I am unable to agree with Newstead on this difference, which is not a constant character in either species. (*b*) Inner flange-like extension of superior clasper greatest length less than greatest width of the clasper in *longipalpis*, and greatest length equal to the greatest width of the clasper in *pallidipes*. This is generally true. (*c*) Long hairs on distal margin, about half the length of the clasper in *longipalpis* and about one-third the length of the clasper in *pallidipes*. This I found is only partly true: if *longipalpis* from Nigeria are compared with *pallidipes* from coastal regions in Tanganyika, about one per cent. of both species prove to be exceptions to this rule. With *pallidipes* from Uganda, however, about 50 per cent. have long hairs and the remainder short. There appears to be a cline in this character across Africa from east to west, but not from north to south. (*d*) Longest hairs of editum equal in length to the clasper in *longipalpis* and one-half the length of the clasper in *pallidipes*. Here again the character is not constant from east to west, but varies as a cline, but is constant from north to south.

There is another variation in the genitalia of both *longipalpis* and *pallidipes* that has not been previously noted. This is a formation of the inner flange-like extension of the superior claspers to form a median lobe-like process as found in *morsitans* and *swynnertoni*. A similar formation has already been noted by Vanderplank (1947), and it is suggested that this might be due to hybridization with *morsitans*. This character is shown in Plate 3, photographs K and L, in the previous paper on the classification of *Glossina morsitans* from Whoima, Uganda, where it occurs in about 1 to 2 per cent. of the population.

Plate 3, photograph M, shows a slightly different form of the same median-lobe formation, from a specimen caught near Mbulu, Tanganyika—this was the only one from the 500 examined from this area. The median lobe-like processes are slightly chitinized, whereas the normal inner flange of *pallidipes* is not chitinized. This character has so far only been found amongst *pallidipes* where it occurs with *G. morsitans* and is frequent in Uganda, but relatively less frequent to the east, when it is found in 1 in 500 to 600 *pallidipes* in the central *morsitans* belt. It has not been found in *pallidipes* from the coastal regions of Kenya, Tanganyika or Zululand to date. One specimen of *G. longipalpis* from Nigeria has been found with a similar median-lobe process.

This character may be a simple or linked recessive, or may be due to introgressive hybridization with *morsitans*. Further observations and experiments are necessary before the exact genetical nature of the character can be determined.

The antennae of *longipalpis* and *pallidipes* have been carefully compared by photomicrographs and no constant differences between them were found.

G. austeni Newstead.

Numerous *austeni* have been examined from various localities in Kenya, Tanganyika, Portuguese East Africa and Zululand. Little variation has been noted except that the size of the inner flange or median lobes varies in a cline from north to south. It is small in the north as shown in Plate 3, photograph N, and large in the south. There are also slight differences in the relative sizes of the superior claspers, but none of these variations is sufficient to suggest that any races of *austeni* exist.

Summary.

1. Variations in the morphological characters of *G. pallidipes* and *G. longipalpis* are noted.

2. *G. pallidipes* collected in Kisii (Kenya), Shinyanga and Kingolwira (Tanganyika), which are several hundred miles apart from each other, interbreed normally.

3. A median-lobe-like character is found in 1–2 per cent. of *pallidipes* from Uganda and becomes less frequent to the east. The character may be a recessive or due to introgressive hybridization with *morsitans*. So far it has only been found in *pallidipes* from country also inhabited by *morsitans*.

4. A slight variation in the male genitalia of *austeni*, as a north to south cline, is noted.

Acknowledgments.

I wish to thank Professor P. A. Buxton, C.M.G., F.R.S., and Dr. F. I. van Emden for their help; also others who have kindly supplied material for this investigation.

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THE CLASSIFICATION OF *GLOSSINA PALPALIS*, INCLUDING THE DESCRIPTIONS OF NEW SUBSPECIES AND HYBRIDS.

By F. L. Vanderplank, Ph.D.

1. Two New Subspecies of Tsetse Flies, *Glossina palpalis gambiensis* and *G. p. angolensis*, and a Revised Account of Other Subspecies and Species of the *palpalis* Group.

The original species of *Glossina palpalis* was described by Robineau-Desvoidy under the name of *Nemorhina palpalis*. These specimens were collected in the Belgian Congo, the exact locality is not known. Newstead described the subspecies *fuscipes* as a separate species in 1910, later as a variety and still later as a subspecies. Newstead, in his paper "On the genital armature of the males of *Glossina medicorum* Austen and *Glossina tabaniformis* Westwood" (1910), adds the following note: "I may here add, in connection with this subject, that I have recently examined a single male *Glossina palpalis* which was captured by Dr. Alan Kinghorn in N.E. Rhodesia, and have found that the superior claspers of this specimen are not specifically identical with those found in Gambia and elsewhere on the West Coast of Africa. As the microscopical preparation of the armature is not in a perfect state of preservation, I cannot yet add any further particulars; but as far as I can judge at present I believe it to be representative of a distinct race." Zumpt (1935) described this eastern variety from Kasanga, Lake Tanganyika, as a new species, naming it *martinii*, and raised *fuscipes* to specific rank. Patton (1936) disagreed with Zumpt, discredited *martinii* even as a variety and considered that *fuscipes* was merely a variety of typical *palpalis*. Rather more surprising is the fact that he noted that *palpalis* from the Congo-Angola border had a striking and peculiar character of its phallosomes, so he took this as his type-form for *G. palpalis*. Other varieties of *palpalis* have been recorded. Newstead (1907) described *palpalis* from Tshumbiri, Lower Congo, as *G. maculata*; later, in 1924, he described it as a variety of *G. palpalis*, but only one specimen exists. J. W. Scott Macfie described a small race from Ilorin, Nigeria, in 1913, with abdominal markings similar to *G. tachinoides*, which was shown to be *G. palpalis* by Newstead and Austen. Austen (1915) described a colour variety of *G. palpalis* which he named *wellmani* from the Katumbala River, Angola. Simpson (1918) described another colour variety which he called *pallida*.

In the present investigation batches of genitalia, usually from 20 to 50 males, have been prepared and examined from material collected in as many localities as possible. Also the material available in the British Museum, the London School of Hygiene and Tropical Medicine and the Tsetse Research Department of Tanganyika has been examined. Besides the male genitalia, the antennae, scutella, legs and other portions of the fly's anatomy have also been similarly prepared and compared.

Results.

As pointed out above, there has been considerable divergence of opinion as to whether any varieties, subspecies or other species of *G. palpalis* exist. This position has been clarified by extensive cross-breeding experiments between

different subspecies of *palpalis*. In these experiments it was found that although these species would intermate more or less readily, owing to physiological differences the males killed the females, due to their claspers piercing the female's abdomen. For details, the original work should be consulted. On these and other grounds it was concluded that *G. palpalis palpalis*, from Nigeria, *G. p. fuscipes* from Uganda and *G. p. martinii* from Lake Tanganyika, could be regarded as distinctive *subspecies*, but were not sufficiently different or separated to be raised to specific rank. It was found that there is a cline existing between the various subspecies, and a graduation of characters as would be expected. It was also found that *G. palpalis* from the north-western extremity of its distribution was distinctive in many ways from the other subspecies, and it is proposed to name this subspecies *G. palpalis* **gambiensis.** Again, *palpalis* from the south-western extremity of its distribution in Angola was found to have a distinctive coloration and male genitalia. Austen had already named this colour variety as *wellmani*, but the name *wellmani* has been applied to colour varieties from other parts, and both Austen and Newstead failed to recognize any distinctive features in the genitalia of the original *wellmani*, so it is proposed to name this new subspecies as *G. palpalis* **angolensis.** There is a cline which exists, or did exist until comparatively recent times, between all subspecies; and a natural graduation from one subspecies to the other. *G. p. palpalis* is intermediate between *G. p. gambiensis* and *G. p. martinii*. *G. p. martinii* is intermediate between *G. p. palpalis* and *G. p. fuscipes* and *G. p. angolensis*.

Comparison of Characteristics.

Coloration is variable amongst each subspecies and between individuals in various localities; similarly, there is a considerable overlap and seasonal variation in size. The antennae and other portions of the fly's anatomy do not show any consistent differences except between the apical scutellar bristles of the male from the north-western extremity and those of the rest of *palpalis*. However, it is possible to make some generalizations on these characters and these are shown in Table I below.

TABLE I.—*Usual Colour and Size of Various Subspecies of* G. palpalis. *These Characters are, however, Variable Seasonally and with Locality.*

	G. p. gambiensis.	*G. p. palpalis.*	*G. p. martinii.*	*G. p. fuscipes.*	*G. p. angolensis.*
Colour of background of abdomen	Light brown	Grey to dark brown	Light yellow or yellow-grey	Grey to dark grey	Grey-brown
Banding . .	Dark brown to black, rather indefinite	Black and definite	Black and definite	Black and definite	Black, often indefinite
Size . . .	Small, often smaller than *tachinoides*	Small to medium	Largest subspecies	Medium to large	Small to medium

The only reliable characters for diagnostic purposes are the parameres or inferior claspers, but the superior claspers also show a graduation in size and shape with the subspecies. Absolute size of the superior claspers is not a

dependable character, since small individuals have small superior claspers, and small flies bred from the larger subspecies in the laboratory may have smaller superior claspers than any wild subspecies. The relative sizes and shape of the superior claspers would be a definite diagnostic feature if a suitable and reliable method of measuring them could be obtained. The superior claspers from various subspecies and intermediate forms from different localities are shown in Plate 1.

The claw of *G. p. gambiensis* (A) is curved outward ; in *G. p. palpalis* (E) it is straight ; in the intermediate from Leopoldville (F) it is curved inwards ; in *G. p. angolensis* (G), *G. p. martinii* (H) and *G. p. fuscipes* (I and J) it is curved ventrally (away from the camera). As can be seen best from the photograph, there is a considerable variation in shape in the superior claspers, especially in *G. p. angolensis* (G), which is very narrow and small. These shapes are more or less constant amongst individuals from each locality, and have been carefully compared by photographing them to the same scale and superimposing the negatives for direct comparison. All the photographs in Plate 1 are taken to the same scale.

The Parameres or Inferior Claspers.

To examine these properly, two preparations are necessary : (*a*) The parameres are removed, preferably from a freshly killed specimen, and mounted in a medium, such as polyvinyl alcohol, without any flattening or pressure, or taken from a spirit-preserved specimen and mounted in balsam without any treatment, flattening or pressure. This method reveals the way in which the

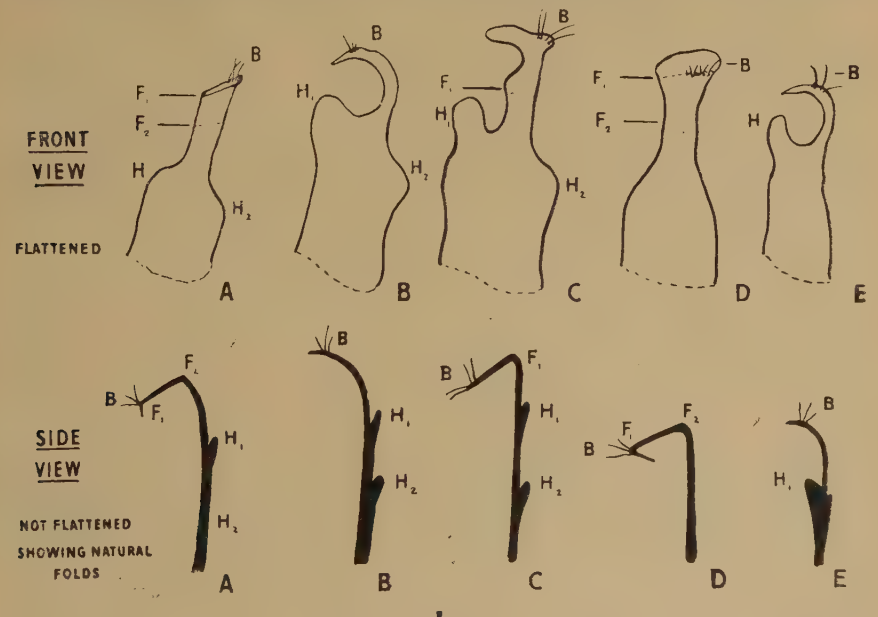


FIG. 1.—Parameres of (A) *Glossina palpalis palpalis*; (B) *G. p. fuscipes*; (C) *G. p. martinii*; (D) *G. p. gambiensis* subsp. n.; (E) *G. p. angolensis* subsp. n. B, apical bristles; F, first and second folds (*fuscipes* and *angolensis* are not folded but curved); H, first and second humps or shoulders.

parameres are folded and bent, which is an important diagnostic feature. Patton recommended that the parameres should be mounted without flattening or pressure, but failed to recognize the significance of the manner in which the parameres are bent. Dried specimens become distorted and are unreliable. (*b*) The genitalia are macerated in caustic potash, as recommended by Newstead, washed and taken through into absolute alcohol; then the parameres are separated from the genitalia, flattened and mounted with pressure. This gives the outline and shape. However, I have not been able to mount the parameres of *G. p. gambiensis* successfully by this method, as they are folded in such a manner that they always break on flattening. Figure 1 shows diagrammatically how the parameres are bent and folded, when viewed from the sides (antero-posteriorly), and their flattened appearance from the front. The shape of the flattened parameres is also diagnostic for each subspecies, also for other species of the same group, namely, *G. pallicera*, *caliginea*, *newsteadi* and *tachinoides*. The number of bristles present near the apex or "heel" of the paramere varies with the subspecies, but is constant amongst individuals in each locality. The flattened parameres are shown in Plate 2.

Table II summarizes and compares the characters of these various subspecies of *palpalis* and other members of the *palpalis* group. The characters of the parameres of hybrids of *palpalis* (see below) are also included in this table for direct comparison.

EXPLANATION OF PLATES.

PLATE 1.

Superior claspers.

(A) *G. p. gambiensis* from Gambia. (B) Intermediate from Sierra Leone. (C) Intermediate from Liberia. (D) Intermediate from the Gold Coast. (E) *G. palpalis palpalis* from Nigeria. (F) Intermediate between *G. p. palpalis* and *G. p. martinii* from Leopoldville, Belgian Congo. (G) *G. p. angolensis* from Angola. (H) *G. p. martinii* from Mpulungu, N. Rhodesia. (I) *G. p. fuscipes* from Entebbe, Uganda. (J) *G. p. fuscipes* from Maboko Island, Kenya.

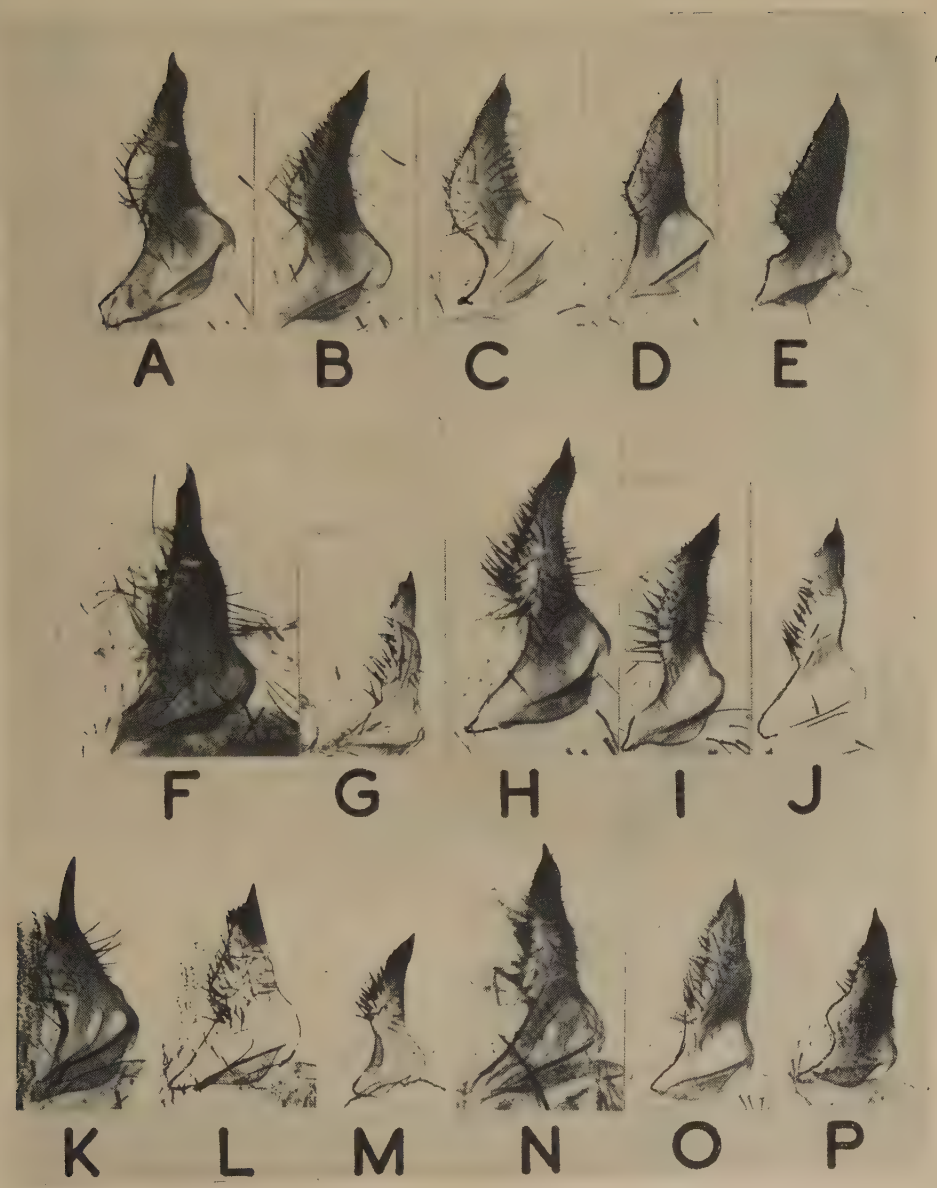
Included for comparison are: (K) *G. caliginea* from the Cross River, Nigeria. (L) *G. pallicera* from Kumasi, Ashanti. (M) *G. tachinoides* from Kaduna, Nigeria; also (N) Laboratory-produced hybrid *G.* "*paltinii*" from crossing a male *G. p. palpalis* with a female *G. p. martinii*. (E × H). (O) Laboratory hybrid *G.* "*martinipes*" produced by crossing a male *G. p. martinii* with a female *G. p. fuscipes* (H × I). (P) Laboratory hybrid *G. p.* "*fuspalis*" produced by crossing a male *G. p. fuscipes* with a female *G. p. palpalis*.

PLATE 2.

Parameres or inferior claspers.

(A) *G. p. palpalis* from Kaduna, Nigeria. (B) *G. p. fuscipes* from Entebbe, Uganda. (C) *G. p. martinii* from Mpulungu, N. Rhodesia. This is considerably larger than those of other subspecies. (D) *G. p. gambiensis* from Gambia. As explained above it has not been possible to flatten this preparation properly. (E) *G. p. angolensis* from Angola. This is similar to *G. p. fuscipes*, but the "leg" is narrower and more extended than in the latter. (F) *G. palpalis* intermediate type from Leopoldville, Belgian Congo. When mounted, unflattened, without pressure, it appears to be similar to *G. p. palpalis*. (G) *G. tachinoides* from Kaduna, Nigeria. (H) *G. pallicera* from Ashanti. (I) *G. caliginea* from the Cross River, Nigeria. (J) Drawing of the paramere of *G. newsteadi* from the Congo, from a preparation in the British Museum (Natural History).

Laboratory-bred hybrids. (K) *G. palpalis* "*paltinii*." (L) *G. palpalis* "*fuscitinii*." (M) *G. palpalis* "*fuspalis*." (N) *G. palpalis* "*martinipes*." (O) *G. palpalis* "*martinipes*" showing natural folding.



F. L. Vanderplank. Genitalia of *Glossina palpalis.*

F. L. Vanderplank.

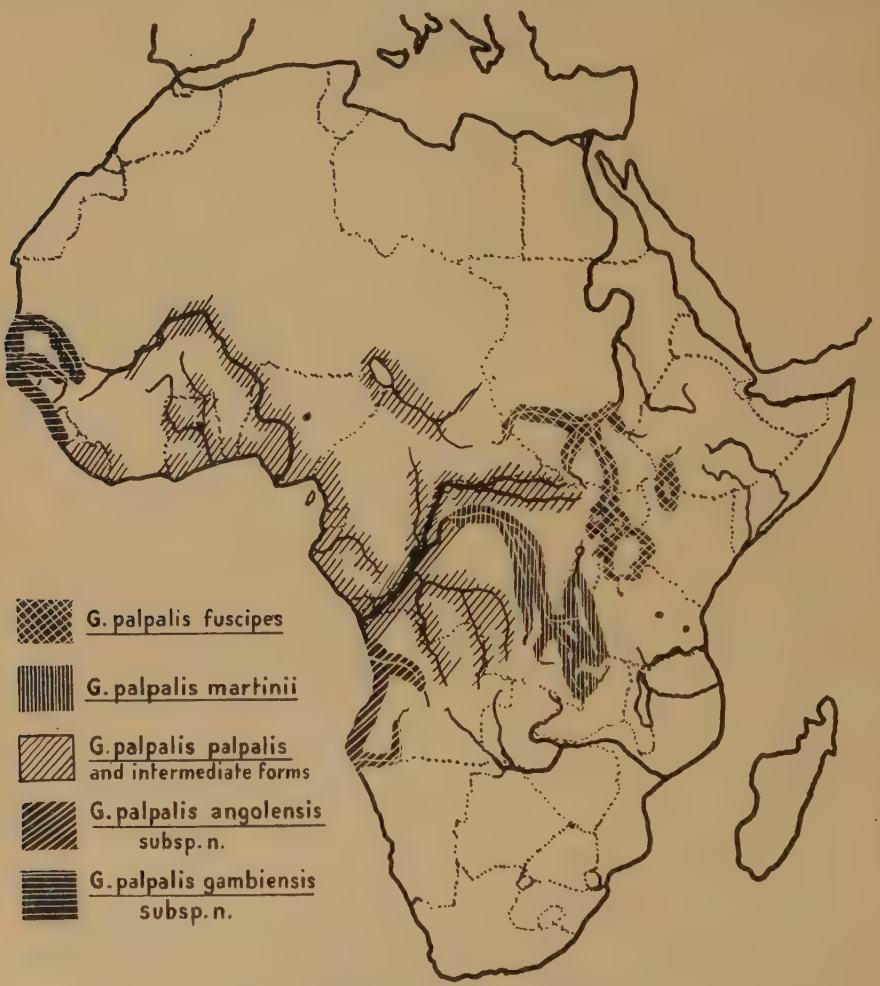
Genitalia of *Glossina palpalis*.

TABLE II.—*Characteristics of the Parameres of Various Species and Hybrids of the* palpalis *Group.*

SPECIES.	"Toe."	"Heel."	Fold 1.	Fold 2.	"Hump A"	"Hump B."	Bristles on or near "heel."	Remarks.
G. palpalis fuscipes ex Uganda	Tapering and pointed	Absent	Absent	Near apex	Pronounced	Pronounced	Average 3	Very "hairy"
G. palpalis martinii ex N. Rhodesia	Blunt	Pronounced	,,	Below "foot"	Very pronounced	Absent	2 and 2	ditto
G. palpalis palpalis ex Nigeria	Pointed	Slight	Usually absent	Midway on "leg"	Absent	Slight	Average 3	Few "hairs"
G. palpalis gambiensis ex Gambia	Tapering and blunt	,,	Across apex giving "flap"	Diagonal one-third from apex	Slight	Absent	4–6	Moderately "hairy"
G. palpalis angolensis ex Angola	Curved and blunt	None	Absent	Absent	Pronounced	,,	3	Few "hairs"
G. tachinoides ex Nigeria	Pointed	Pointed	Absent	Slight bend	Very pronounced	Present near base	Several small "bristles"	Small "hairs"
G. pallicera ex French Cameroons	Tapering and blunt	Large and separate	No fold, curved	Curved	Slight	Absent	1 or 2	Moderately "hairy"
G. caliginea ex French Cameroons	Hood-end and cleft		no fold, curved	,,	Absent	Pronounced at base	3	"Hairs" grouped
HYBRIDS.								
G. palpalis "*fuspalis*"	Blunt	Slight	Small at apex	Midway on "leg"	Slight	Absent	3	Few "hairs"
G. palpalis "*paltinii*"	Rounded	Present	Absent	Midway on "leg"	Pronounced	,,	4	ditto
G. palpalis "*martinipes*"	Blunt	,,	,,	?	Very pronounced	Slight	4	,,
G. palpalis "*fuscitinii*"	Tapering and pointed	Absent	,,	Near apex	ditto	Absent	3	"Hairy"

Distribution.

The approximate distribution of the various subspecies of *G. palpalis* is shown in Map 1. *G. p. fuscipes* is most probably completely isolated from the rest of *palpalis* and found around and on various islands in Lake Victoria; also on the Upper Nile and rivers in Uganda. The shape of the parameres varies



Map 1.—Distribution of *G. palpalis* subspecies.

in a cline from north to south, but this variation is not so pronounced as the differences between the subspecies. Since *fuscipes* on some of the islands are completely isolated from the rest of the cline and probably have been for several thousands of years, further study of these isolated groups might be of interest. *G. p. martinii*, the type form, is found south of Lake Tanganyika, and there is a slight but insignificant variation around the lake. *G. p. martinii*, collected near Kigoma, Tanganyika, cross normally with those collected near

Mpulungu, N. Rhodesia, approximately 100 miles south. *G. p. martinii* characteristics persist well into the Congo, and to its south-eastern limits around Lake Mweru and Lake Bangweulu, N. Rhodesia. Patton illustrates a superior clasper from a specimen stated to come from the Zambesi; this must be an error, since no *palpalis* occur on the River Zambesi. *G. p. martinii* forms a cline with *G. p. palpalis*, which is, as far as information is available, still continuous. *G. p. palpalis* is found in the western parts of the Belgian Congo and territories north of this. The specimens from Nigeria are most like Newstead's description of the genitalia; no previous accounts were given. To the north of Nigeria they become more intermediate between typical *palpalis* and *gambiensis*. *G. p. palpalis* from Nigeria interbreed normally with those from the Gold Coast. *G. p. gambiensis* typical form is found in Gambia and Senegal, and although in comparatively recent geological times formed a cline with *palpalis*, is now severed into several isolated groups. *G. p. angolensis* is distributed along rivers in the west of Angola and the intermediate forms between its extremities and the Congo. Very little information is available as to the extent of its distribution in Angola. Newstead (1924) states that *G. p. palpalis* is found in San Salvador, Portuguese East Africa—presumably this is an error and should read Portuguese West Africa or Angola. *G. palpalis* is not found in Portuguese East Africa.

Summary.

Two new subspecies of *G. palpalis*, namely, *G. p. gambiensis* and *G. p. angolensis* are described in conjunction with the other subspecies of *palpalis* and other species of the *palpalis* group. The distribution of these various subspecies is given.

2. Descriptions of Hybrids Produced by Crossing Various Subspecies of *palpalis* with Each Other.

The cross-breeding of *G. palpalis* subspecies and the results obtained have been described by Vanderplank (1947). Six first generation types of hybrids have been produced to date and two second generation types; also several back-crosses. Many of the male F_1 and F_2 hybrids have been used in further breeding experiments, and unfortunately some of the males were destroyed by insects getting into one storage box prior to detailed examination of their genitalia. These have not yet been replaced.

(a) Hybrid *G. palpalis* "*paltinii*."

Offspring from crossing male *G. p. palpalis* with female *G. p. martinii*. Coloration intermediate, but, as noted above, coloration cannot be used as a diagnostic factor. Similarly, size has no value, since laboratory-bred flies are usually very much smaller than wild ones. The superior claspers, Plate 1, N, are intermediate between the two parents, but distinctive from any wild intermediate forms so far found in the natural cline. The parameres are shown in Plate 2, K, and are again intermediate between the parents, but distinctive from wild intermediate forms. Their characteristics are given in Table II.

(b) Hybrid *G. palpalis* "*palipes*."

Offspring from crossing *G. p. palpalis* with female *G. p. fuscipes*. Two female and one male hybrid were produced; unfortunately the male was destroyed before detailed examina-

tion, and I find that the characters of the female genital plates are too variable between the subspecies for diagnostic purposes.

(c) Hybrid *G. palpalis* "*fuscitinii*."

Offspring from crossing male *G. p. fuscipes* with female *G. p. martinii*. *Martinii* type of coloration is dominant, the superior claspers are intermediate and proportionally small. The parameres are shown in Plate 2, L, and resmble *G. p. fuscipes*, but have some intermediate characters; however, they could not be distinguished from a sample collection of *fuscipes*. Their characteristics are summarized in Table II.

(d) Hybrid *G. palpalis* "*fuspalis*."

Offspring from crossing male *fuscipes* with female *palpalis* and reciprocal cross of "*palipes*," section (*b*). The superior claspers are shown in Plate 1, P, and are slightly different from other types. The paramere is similar to *G. p. palpalis* in its shape and folds. The differences are noted in Table II and it is figured in Plate 2, M.

(e) Hybrid *G. palpalis* "*marpalis*."

Offspring from crossing male *martinii* with female *palpalis* and reciprocal cross of "*paltinii*." Some three females and two males have been produced to date, but unfortunately both males were destroyed before detailed examination was made.

(f) Hybrid *G. palpalis* "*martinipes*."

Offspring from crossing male *martinii* with female *fuscipes* and reciprocal cross to "*fuscitinii*." The superior claspers are shown in Plate 1, O, and have their own intermediate characteristics, which differ from the reciprocal cross. The parameres are intermediate between the parents and considerably larger than the reciprocal cross. This is shown in Plate 2, N, and in its natural folded position, Plate 2, O, and the characters summarized in Table II.

Second Generation Crosses between Hybrids.

martinipes × *martinipes*.—These breed true to hybrid characteristics as described above for *martinipes*.

Discussion.

None of these hybrids is likely to be encountered in the wild state since the subspecies are widely separated, and if they were brought in contact with each other by some agency there are physiological barriers to successful breeding (see Vanderplank, 1947). Type specimens and genitalia of *G. p. gambiensis*, genitalia of *G. p. angolensis*, and each of the various hybrids have been deposited at the British Museum for future reference.

Summary.

Four hybrid *palpalis* are described and two others noted. The hybrids have intermediate but definite characteristics of each particular cross and are unlike any natural intermediate types so far examined.

Acknowledgments.

I particularly wish to thank Professor P. A. Buxton, C.M.G., F.R.S., for the interest and help he has given in this work, for obtaining material from a

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NEW GENERIC NAMES IN STAPHYLINIDAE (COLEOPTERA).

By The Rev. C. E. Tottenham, M.A.

Brundin, 1942 (*Ann. naturh. Mus. Wien* **53** : 129–300) has published an excellent monograph on the subgenus *Hygroecia* Mulsant and Rey, of the genus *Atheta* Thomson. In this subgenus he has included the majority of the British species of the subgenus *Metaxya* Mulsant and Rey, the single species of the subgenus *Peliolurga* Tottenham (= *Pelurga* Mulsant and Rey *nec* Hübner) and the species *Atheta palustris* (Kiesenwetter) from the subgenus *Philhygra* Mulsant and Rey. The result of this regrouping of species is that the names *Hygroecia, Peliolurga, Phryogora* Mulsant and Rey and *Philhygra* all become synonymous, since their types are amongst those species which Brundin includes in *Hygroecia*. The name *Hygroecia* Mulsant and Rey, however, cannot be used for the combined genus, for it is two years later than the other two names of Mulsant and Rey, and of these, *Philhygra* Mulsant and Rey, 1873, having page priority, becomes the name for the subgenus. A further result of Brundin's classification is that the remainder of the species of Mulsant's and Rey's *Philhygra* and *Metaxya* are left without subgeneric names ; the former because the type-species has been removed, the latter because the name is preoccupied by *Metaxya* Walker, 1856 (Lepidoptera). I therefore propose the name *Agaphygra* for the remaining species of the old *Philhygra* with *Homalota subglabra* Sharp, 1869, as its type, and the name *Brundinia* in place of *Metaxya* Mulsant and Rey *nec* Walker. *Brundinia* will, of course, have for its type the species cited by Fenyes, 1918, for *Metaxya* Mulsant and Rey, namely *Homalota meridionalis* Mulsant and Rey.

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